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ABSTRACT

This trade and industrial curriculum guide for power mechanics is designed for vocational power mechanics programs that provide 960 hours of instruction. The introductory section provides a statement of philosophy, block time schedule, and the objectives for power mechanics. Following the introductory section, fourteen blocks of instruction are presented: (1) orientation; (2) introduction to power mechanics; (3) principles of the internal combustion engine; (4) two-cycle engine; (5) four-cycle engine; (6) introduction to rotary engines; (7) power measurement; (8) operation, routine maintenance, and storage; (9) review; (10) diagnosis and tune up; (11) power transmission; (12) fluid power; (13) pneumatic power; and (14) facility management. Each block provides a list of student objectives and a table that contains the topics of instruction, content/method suggestions, and student activities. Appended material includes a list of instructional aids and an example of a unit guide for block 4. (LRA)

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INSTRUCTIONAL GUIDE
FOR
VOCATIONAL POWER MECHANICS
V & TECC CURRICULUM GUIDE

CE 024 119

Trade and Industrial Education Service
Division of Vocational and Adult Education
Virginia Department of Education
and
Division of Vocational and Technical Education
College of Education
Virginia Polytechnic Institute and
State University
Blacksburg, Virginia 24061
September 1979

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Lester G. Duenk

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FOREWORD

This is another in a series of Trade and Industrial Curriculum guides. It is intended that this Power Mechanics Curriculum Guide be used with vocational programs which prepare students to enter the Power Mechanics field.

We have purposely eliminated the binding of these guides so that they may be punched and placed in notebooks, thus making it possible to remove and replace material as needed.

Thanks are expressed to all the instructors listed on the following page and to Dr. Lester G. Duenk who coordinated the development of this guide.

We anticipate that you will find it useful to supplement the guide with appropriate lesson plans and instruction sheets.

Ben L. Baines
State Supervisor
Trade & Industrial Education
Virginia Department of Education
Richmond, Virginia 23216

September 1979

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PREFACE

This curriculum guide is designed to establish standards for power mechanics instruction on a state-wide basis. The material may be used and adapted at the discretion of the instructor to fit the particular teaching situation. The guide, as written, is designed for a 960-hour program.

It is anticipated that this guide will enable the instructor to develop a comprehensive curriculum which includes all supplementary teaching materials such as lesson plans, information sheets, job sheets, assignment sheets, and other teaching aids.

This curriculum guide was developed by a group of Virginia power mechanics instructors taking part in a summer Curriculum Workshop sponsored by the Vocational and Technical Education Division, Virginia Polytechnic Institute and State University, Blacksburg, Virginia; and the Virginia Department of Education, Division of Vocational and Adult Education, Trade and Industrial Education Service.

The instructors who participated in the development of this guide are as follow:

Instructors

Frank D. Glasscock, Buchanan County Vocational School, Grundy
N. G. Johnson, Piedmont Technical Education Center, Culpeper
Larry Q. Looney, Buchanan County Vocational School, Grundy
Roy E. Osborne, Buchanan County Vocational School, Grundy
Elmer C. Pixley, Bluestone Senior High School, Skipwith
A. W. Ride, Jr., Thomas Dale High School, Chester
E. A. Trainum, Piedmont Technical Education Center, Culpeper
J. W. Williams, Spotsylvania Senior High School, Spotsylvania

Coordinating Instructors

R. W. Williams, Lecturer
Vocational and Technical Education
Virginia Polytechnic Institute and
State University

Lester G. Duenk, Professor
Vocational and Technical Education
Virginia Polytechnic Institute and
State University

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PHILOSOPHY

Today as never before in history, young people are meeting new scientific and technological advances in business and industry. The world of the future requires a departure from the traditional kind of education where academic learning only was considered paramount. Through vocational education the student can develop the understanding and skill to cope with the technological age.

The power mechanics field is expanding rapidly. The opportunities for young people who are interested in making a career in power mechanics are almost limitless. The purpose of the power mechanics program in Virginia secondary schools is to serve the needs of youth who will pursue a career in the exciting new world of power technology.

BLOCK TIME SCHEDULE (Suggested)

<u>Block Number</u>	<u>Lecture</u>	<u>Laboratory</u>	<u>Total</u>
1. Orientation	5	10	15
2. Introduction to Power Mechanics	4	16	20
3. Principles of Internal Combustion Engine Design	30	20	50
4. Two Cycle Engine	40	180	220
5. Four Cycle Engine	20	100	120
6. Introduction to Rotary Engines	20	0	20
7. Power Measurement	10	0	10
8. Operation, Routine Maintenance, and Storage	5	20	25
9. Review	5	10	15
10. Diagnosis and Tune Up	15	125	140
11. Power Transmission	15	125	140
12. Fluid Power	40	65	105
13. Pneumatic Power	20	40	60
14. Facility Management	15	5	20
2nd Year Total	110	370	480
GRAND TOTAL			960

OBJECTIVES FOR POWER MECHANICS

The student will:

1. know the opportunities available to power mechanics technicians;
2. know and understand the school policies as they pertain to the power mechanics program;
3. develop the proper attitude necessary to succeed in the field of power mechanics;
4. develop skill and knowledge in internal combustion engine operation and repair;
5. develop skill and knowledge in the four cycle engine operation and repair;
6. develop skill and knowledge in the two cycle engine operation and repair;
7. develop skill and knowledge in the rotary engine operation and repair;
8. understand and practice basic concepts of power measurement;
9. develop the skill and knowledge necessary to maintain properly the internal combustion engine;
10. develop the skill and knowledge necessary to perform properly all functions relating to tune up;
11. develop the skill and knowledge necessary to perform properly power transmission fundamentals;
12. develop understanding of and skill in fluid power application;
13. develop understanding of and skill in pneumatic power application; and
14. understand and practice the organization necessary for good facility management.

BLOCK ONE
ORIENTATION

- A. School Policies
- B. General Safety
- C. Job Opportunities
- D. Shop Policies
- E. Energy Conservation

BLOCK ONE
ORIENTATION

OBJECTIVES:

The student will know the opportunities available to power mechanics technicians. Specifically the student will be able to:

- A. Complete a written test on safety rules;
- B. List job opportunities available to power mechanics technicians.

The student will know the school policies as they pertain to the power mechanics program. Specifically the student will be able to:

- A. List the steps which will conserve energy in the school;
- B. Explain school policies pertaining to the program;
- C. State policies that govern the power mechanics laboratory.

BLOCK ONE - - ORIENTATION

Topics of Instruction	Content/ Method	Student Activities
A. School Policies	Lecture - introduce students to information furnished by the individual school. Stress all operational policies.	Complete all applicable forms. Explain school rules, policies, and give reasons for following them.
B. Safety	Lecture/Demonstration Emphasize the importance of safety in the following areas: a. Work clothes b. Jewelry c. Lifting d. Good housekeeping e. Electrical equipment f. Removal of safeguards g. Cuts and abrasions h. Defective equipment i. Proper use of tools j. Ventilation (exhaust system) k. Long hair	Participate in discussions. Written test on safety rules.
C. Job Opportunities	Lecture Motivate students by covering all areas of possible employment and future advancement: a. Specialty Mechanic b. Shop Supervisor c. Service Salesperson d. Service Manager e. Sales Manager f. Parts Manager g. Jobber Salesperson h. Manufacturer's Representative i. Technical Teacher	Participation and take notes. List job opportunities available to power mechanics technicians. Explain advancement possibilities.
D. Lab Policies	Lecture Instruct the student in proper procedures covering the following areas: a. Equipment b. Jack stands c. Horse play in the shop	Class discussion List all policies to be followed in the laboratory. Explain reasons for each.

BLOCK ONE - - ORIENTATION

Topics of Instruction	Content/ Method	Student Activities
D. Lab Policies (Cont.)	d. Batteries e. Gasoline f. Air nozzles g. Safety glass h. Chemicals (shop) i. Good work habits j. Emergency plans	
E. Energy Conservation	Lecture Emphasize the most important areas of energy conservation. a. Turn off all electric equipment and lights when not in use. b. Close all doors and windows. c. Do not use excessive gasoline.	Class discussion List steps which will conserve energy in school and at home.

BLOCK TWO

INTRODUCTION TO POWER MECHANICS

- A. History of power sources
- B. Importance of the power mechanics technician
- C. Nomenclature, use, care, maintenance, and safety involved with hand tools
- D. Nomenclature, use, care, maintenance, and safety involved with power tools
- E. Fastening devices

BLOCK TWO

INTRODUCTION TO POWER MECHANICS

OBJECTIVES:

The student will gain basic knowledge in the field of power mechanics. Specifically, the student will be able to:

- A. Explain the history of power sources;
- B. List uses of the internal combustion engine;
- C. Explain how to use hand tools in a safe manner;
- D. Explain how to use power tools in a safe manner; and,
- E. Identify and explain the uses of fastening devices.

BLOCK TWO - - INTRODUCTION TO POWER MECHANICS

Topics of Instruction	Content/ Method	Student Activities
A. History of Power Mechanics	Lecture Relate information concerning the invention of the first internal combustion engine in terms of: a. Achievements b. Improvements c. Present uses	Class discussion Write an essay on the history of power sources. List uses of the present day internal combustion engine.
B. Importance of the Power Mechanics Technician	Lecture Relate information concerning the importance of the power mechanics technician.	Class discussion
C. Nomenclature, use, care, maintenance, and safety involved with hand tools	Lecture/Demonstration Discuss the safe and proper use of hand tools. Discuss the proper care and maintenance of hand tools.	Student participation in the safe, proper use, and maintenance of various hand tools.
D. Nomenclature, use, care, maintenance, and safety involved with power tools	Lecture/Demonstration Discuss the safe and proper use of power tools. Discuss the proper care and maintenance of power tools.	Student participation in the safe, proper use, and maintenance of various power tools.
E. Fastening devices	Lecture/Demonstration Discuss the purpose, construction, and uses of various types of fastening devices. a. Threaded bolts and nuts b. Keys and pins c. Clamps and snap rings d. Washers	Class discussion and practice. Identify various fastening devices and demonstrate their uses.

BLOCK THREE

PRINCIPLES OF THE INTERNAL COMBUSTION ENGINE

- A. The Two Cycle Engine
- B. The Four Cycle Engine
- C. Rotary Design Engine

BLOCK THREE

PRINCIPLES OF THE INTERNAL COMBUSTION ENGINE

OBJECTIVES:

The student will develop skill in and knowledge of internal combustion operation and repair. Specifically the student will be able to:

- A. Explain the operation of the two cycle engine;
- B. Explain the operation of the four cycle engine;
- C. Explain the operation of the rotary design engine; and,
- D. Draw designs of the various engines depicting nomenclature and operating principles.

BLOCK THREE - - PRINCIPLES OF THE INTERNAL COMBUSTION ENGINE

Topics of Instruction	Content/ Method	Student Activities
A. Four Cycle Design	Lecture/Demonstration Show and discuss the different designs of engine cylinder blocks and explain terminology used to identify each. a. Horizontal b. Vertical c. Opposed d. V-Type	Draw sketches which show different designs. Identify components and their use.
B. Two Cycle Design	Lecture/Demonstration Show and discuss the different designs of the two cycle block and explain the terminology used to identify each.	Draw sketches which show different designs. Identify components and their use.
C. Rotary Engine Design	Lecture Explain the history, basic operation, and geometry of the rotary engine.	Take notes and participate in class discussion. Draw sketches which show different designs. Identify components and their uses.

BLOCK FOUR
TWO CYCLE ENGINE

- A. Fuel Systems and Governors
- B. Lubrication
- C. Ignition and Starter Systems
- D. Cooling Systems
- E. Manufacturer's Specifications
- F. Tune Up
- G. Troubleshooting
- H. Reconditioning Engine Block Assemblies

BLOCK FOUR

TWO CYCLE ENGINE

OBJECTIVES:

The student will develop skill and knowledge in two cycle engine operation and repair. Specifically, the student will be able to:

- A. Disassemble, inspect, and repair governors and fuel systems.
- B. Explain the function and components of the lubrication system.
- C. Disassemble, inspect, and repair component parts of the ignition and starter systems.
- D. Inspect, clean, and repair various components of the cooling system.
- E. Locate and interpret manufacturer's specifications.
- F. Explain and demonstrate engine tune up.
- G. Explain and demonstrate proper troubleshooting sequence.
- H. Explain and demonstrate how to recondition properly a given engine block assembly.

BLOCK FOUR - - TWO CYCLE ENGINE

Topics of Instruction	Content/ Method	Student Activities
A. Fuel Systems and Governors	Lecture/Demonstration The different fuel systems: a. Fuel filter service b. Air cleaner service c. Carburetion	Classroom discussion and practice. Remove and replace fuel filter and air cleaner. Make adjustments and repairs to carburetors.
	The different speed governing devices: a. Purpose b. Types c. Servicing	Clean and repair governor assemblies.
	The fuel injection system: a. Injector pump b. Injector	Clean and adjust injector pump and injector.
	Properties and uses of various diesel fuels.	Identify the various diesel fuels.
B. Lubrication	Lecture/Demonstration Types of lubrication systems: a. Purpose of lubrication. b. Types of oils used c. Types of systems	Classroom discussion and practice. Examine and test various types and uses of lubrication oils.
		Disassemble and inspect oil pumps.
C. Ignition and Starter Systems	Lecture/Demonstration Reading Assignment, Audio Visuals	Classroom discussion, practice and reading assignment. Disassemble and inspect ignition system parts. Repair and reassemble. Be able to state and apply Ohm's Law.
	Explain the purpose of the ignition system: a. Function of the ignition circuit b. Ohm's Law c. Types d. Magnetism e. Components	Disassemble and inspect various types of starters. Repair and reassemble.
	Explain the different types of starting systems: a. Mechanical b. Electric	

BLOCK FOUR - - TWO CYCLE ENGINE (continued)

Topics of Instruction	Content/ Method	Student Activities
D. Cooling Systems	Lecture/Demonstration Explain purpose of engine cooling systems: a. Types b. Principles c. Temperature effects on wear and economy. d. Periodic servicing and maintenance	Inspect, clean and repair various components of the cooling system and practice service techniques.
E. Manufacturer's Specifications	Lecture/Demonstration The proper methods of locating engine specifications and identification: a. Engine nameplates b. Manuals and parts catalogs	Classroom discussion and practice. Identify various engines using manufacturer's specifications.
F. Tune Up	Lecture/Demonstration Proper tune up procedure: a. Tune up instruments b. Small engine tune up	Classroom discussion and practice. Demonstrate tune up procedures and explain each step in detail.
G. Trouble-shooting	Lecture/Demonstration The procedure for locating troubles and faulty parts by isolating, testing, and process of elimination. a. Checks when engine fails to start b. Checks when engine misses under load c. Checks when engine lacks power d. Areas to cover when the engine knocks e. Checks when engine overheats	Classroom discussion and practice. Demonstrate basic trouble-shooting techniques, properly using various testing equipment.

BLOCK FOUR - - TWO CYCLE ENGINES (Continued)

Topics of Instruction	Content/ Method	Student Activities
H. Reconditioning Engine Block Assemblies	Lecture/Demonstration Disassembly procedures, inspection and measuring parts, cleaning, and assembly: a. Disassembly b. Cylinder head c. Oil pan d. Connecting rod e. Piston f. Valves g. Camshaft h. Bearings i. Crankshaft	Classroom discussion and practice. Completely disassemble, inspect parts, measure clearances and reassemble various types of engines. Identify various parts of an engine.

BLOCK FIVE

FOUR CYCLE ENGINE

- A. Fuel Systems and Governors
- B. Lubrication
- C. Ignition and Starter Systems
- D. Cooling Systems
- E. Manufacturer's Specifications
- F. Tune Up
- G. Troubleshooting
- H. Reconditioning Engine Block Assemblies

BLOCK FIVE
FOUR CYCLE ENGINE

OBJECTIVES:

The student will develop skill in and knowledge of four cycle engine operation and repair. Specifically, the student will be able to:

- A. Disassemble, inspect, and repair governor and component parts of the fuel system.
- B. Explain the function and components of the lubrication system.
- C. Disassemble, inspect, and repair component parts of the ignition and starter system.
- D. Inspect, clean, and repair various components of the cooling system.
- E. Locate and interpret manufacturer's specifications.
- F. Explain and demonstrate engine tune up.
- G. Explain and demonstrate proper troubleshooting sequence.
- H. Explain and demonstrate how to recondition properly a given engine block assembly.

BLOCK FIVE - - FOUR CYCLE ENGINE

Topics of Instruction	Content/ Method	Student Activities
A. Fuel Systems and Governors	Lecture/Demonstration The different fuel systems are: a. Fuel filter service b. Air cleaner service c. Carburetion	Classroom discussion and practice. Remove and replace fuel filter and air cleaner. Make adjustments and repairs to carburetor.
	The different speed governing devices: a. Purpose b. Types c. Servicing	Clean and repair governor assemblies.
	The fuel injection system: a. Injector pump b. Injector	Clean and adjust injector pump and injector
	Properties and uses of various diesel fuels.	List the various diesel fuels. Explain their uses and properties.
B. Lubrication	Lecture/Demonstration Types of lubrication systems: a. Purpose of lubrication b. Types of oils used c. Types of systems	Classroom discussion and practice. Explain the lubrication system. Examine and test various types of lubricating systems. Understand various types and uses of lubrication oils. Disassemble and inspect oil pumps.
C. Ignition and Starter Systems	Lecture/Demonstration Use audio visuals The purpose of the ignition system: a. Function of the ignition circuit b. Ohm's Law c. Types d. Magnetism e. Component parts	Classroom discussion, practice, and reading assignment. Disassemble and inspect ignition system parts. Repair and reassemble. State and apply Ohm's Law.
	Explain the different types of starting systems: a. Mechanical b. Electrical	Disassemble and inspect various types of starters. Repair and reassemble.

BLOCK FIVE - - FOUR CYCLE ENGINE (Continued)

Topics of Instruction	Content/ Method	Student Activities
D. Cooling Systems	Lecture/Demonstration Purpose of engine cooling systems: a. Types b. Principles c. Temperature effects on wear and economy d. Periodic servicing and maintenance	Inspect, clean, and repair various components of the cooling system and practice correct service techniques.
E. Manufacturer's Specifications	Lecture/Demonstration The proper methods of locating engine specifications and identification: a. Engine nameplates b. Manuals and parts catalogs	Classroom discussion and practice. Identify various engines using manufacturer's specifications.
F. Tune Up	Lecture/Demonstration Proper tune up procedures: a. Tune up instruments b. Engine tune up	Classroom discussion and practice. Demonstrate tune-up procedures and explain each step in detail.
G. Trouble-shooting	Lecture/Demonstration The procedure for locating troubles and faulty parts: (1) Isolating (2) Testing (3) Process of elimination a. Checks when engine fails to start b. Checks when engine misses under load. c. Checks when engine lacks power d. Areas to cover when the engine knocks e. Checks when engine overheats	Classroom discussion and practice. Demonstrate basic trouble-shooting techniques properly, using various testing equipment.

BLOCK FIVE - - FOUR CYCLE ENGINE (Continued)

Topics of Instruction	Content/ Method	Student Activities
H. Reconditioning Engine Block Assemblies	Lecture/Demonstration Disassembly sequence, inspection and measuring parts, cleaning, and assembly: a. Disassembly b. Cylinder head c. Oil pan d. Connector rod e. Pistons f. Valves g. Camshaft h. Bearings i. Crankshaft	Classroom discussion and practice. Completely disassemble, inspect parts, measure clearances, and reassemble various types of engines. Identify various parts of an engine.

BLOCK SIX

INTRODUCTION TO ROTARY ENGINES

- A. Fuel Systems and Governor
- B. Lubrication
- C. Ignition System and Starter
- D. Cooling System

BLOCK SIX

INTRODUCTION TO ROTARY ENGINES

OBJECTIVES:

The student will develop skill in and knowledge of rotary engine operation and repair. Specifically the student will be able to:

- A. Disassemble, inspect, and repair governor and component parts of the fuel system.
- B. Explain the function and components of the lubrication system.
- C. Disassemble, inspect, and repair component parts of the ignition and starter system.
- D. Inspect, clean, and repair various components of the cooling system.
- D. Locate and interpret manufacturer's specifications.

BLOCK SIX - - INTRODUCTION TO ROTARY ENGINE

Topics of Instruction	Content/ Method	Student Activities
A. Fuel Systems and Governors	Lecture/Demonstration Introduction to the fuel system: a. Fuel filter service b. Air cleaner service c. Carburetor disassembly repair and assembly	Classroom discussion and practice. Remove and replace filters. Disassemble filter. Remove and replace air cleaners. Disassemble carburetor, discuss repairs, and reassemble.
	Introduction to speed governors: a. Purpose b. Types c. Servicing	Clean and repair governor assemblies.
	Various fuels: a. Properties b. Types c. Proper handling	
B. Lubrication	Lecture/Demonstration Types of lubrication systems and oil pumps: a. Purpose b. Types c. Pumps	Classroom discussion and practice. Examine and discuss types of lubricating systems, oils and pumps.
C. Ignition and Starter Systems	Lecture/Demonstration Purpose of the ignition system: a. Function of the ignition circuit b. Ohm's Law c. Types d. Magnetism e. Components	Classroom discussion and practice. Disassemble and inspect ignition system parts. Be able to state and apply Ohm's Law.
	The different types of starting systems: a. Mechanical b. Electrical	Disassemble and inspect various types of starters.
D. Cooling Systems	Lecture/Demonstration The purpose of engine cooling systems: a. Types b. Principles c. Temperature effects on wear and economy d. Servicing and maintenance	Inspect, clean, and repair various components of the cooling system. Practice service techniques.

BLOCK SIX - - ROTARY ENGINE (Continued)

Topics of Instruction	Content/ Method	Student Activities
E. Manufacturer's Specifications	Lecture/Demonstration The proper methods of locating engine specifications and identification: a. Engine nameplate b. Manuals and parts catalog	Classroom discussion and practice. Identify various engines, using manufacturer's specifications.

BLOCK SEVEN

POWER MEASUREMENT

- A. Work
- B. Energy
- C. Power
- D. Horsepower
- E. Torque

BLOCK SEVEN
POWER MEASUREMENT

OBJECTIVES:

The student will understand and practice the basic concepts of power measurement. Specifically the student will be able to:

- A. Use proper formulae to measure amount of work done.
- B. Explain types of sources of energy.
- C. Explain the measurement of power.
- D. Explain how horsepower is measured.
- E. Explain how torque is developed and measured.

BLOCK SEVEN - - POWER MEASUREMENT

Topics of Instruction	Content/ Method	Student Activities
A. Work	Lecture/Demonstration Introduction to work: a. Physics involved in producing work. b. How work is accomplished c. How work is measured	Classroom discussion, note taking, and research report. Determine the amount of work done by using proper formulae.
B. Energy	Lecture/Demonstration Introduction to energy: a. Define energy b. Types of energy	Classroom discussion, note taking and research report. Define different types of energy and list sources.
C. Power	Lecture/Demonstration Introduction to power: a. Define power b. Types c. Rating	Classroom discussion, note taking, and research report. Define and explain different types of power and their uses.
D. Horsepower	Lecture/Demonstration Introduction to horsepower: a. Define horsepower b. Types	Classroom discussion, note taking, and research report. List the various categories of horsepower and give an example of each.
E. Torque	Lecture/Demonstration Introduction to torque: a. Define torque b. Turning force c. Torque arm d. Pivot point	Classroom discussion, note taking, and research report. Define torque and how to calculate by using the proper formula.

BLOCK EIGHT

OPERATION, ROUTINE MAINTENANCE, AND STORAGE

A. Consult Manufacturer's Recommendations

BLOCK EIGHT

OPERATION, ROUTINE MANAGEMENT AND STORAGE

OBJECTIVES:

The student will develop the skill and knowledge necessary to maintain properly the internal combustion engine. Specifically, the student will be able to:

- A. Explain how to read, interpret, and apply manufacturer's specifications and recommendations.
- B. Demonstrate proper manner of storing engines, proper maintenance and starting procedures.

BLOCK EIGHT - - OPERATION, ROUTINE MAINTENANCE, AND STORAGE

Topics of Instruction	Content/ Method	Student Activities
A. Manufacturer's Recommendations and Related Service Literature	Lecture/Demonstration The importance of consulting manufacturer's recommendations for maintaining various types of engines:	Classroom discussion, taking notes, and practice. Demonstrate the proper procedure for maintaining and storing various types of engines and starting engines following long periods of storage.

BLOCK NINE

REVIEW

- A. School Policies
- B. General Safety
- C. Job Opportunities
- D. Shop Policies
- E. Energy Conservation

BLOCK NINE

REVIEW

OBJECTIVES:

The student will understand the opportunities available to power mechanics technicians. Specifically, the student will be able to:

- A. Complete a written test on safety rules.
- B. List job opportunities available to power mechanics technicians.

The student will understand the school policies as they pertain to the power mechanics program. Specifically, the student will be able to:

- A. List the steps which will conserve energy in the school and at home.
- B. Explain school policies pertaining to the power mechanics program.
- C. State policies which govern the power mechanics laboratory.

BLOCK NINE - - - REVIEW

Topics of Instruction	Content/ Method	Student Activities
A. School Policies	Lecture Introduce students to information furnished by the individual school. Stress all operational policies.	Complete all applicable forms. Written assignment on school policies.
B. Safety	Lecture/Demonstration Emphasize the importance of safety in the following areas: a. Work clothes b. Jewelry c. Good housekeeping d. Electrical equipment e. Lifting f. Removal of safeguards g. Cuts and abrasions h. Defective equipment i. Proper use of tools j. Ventilation (Exhaust system) k. Long hair	Participate in discussion. Written test on safety.
C. Job Opportunities	Lecture Motivate the students by covering all areas of possible employment and future advancement: a. Specialty mechanic b. Shop supervisor c. Service salesperson d. Service manager e. Sales manager f. Parts manager g. Jobber salesperson h. Manufacturer's representative i. Technical teacher	Participate and take notes. List job opportunities available to the power mechanic technician.

BLOCK NINE - - - REVIEW (continued)

Topics of Instruction	Content/ Method	Student Activities
D. Laboratory Policies	Lecture Instruct the student in proper procedures covering the following areas: a. Equipment b. Jack stands c. Horse play in shop d. Batteries e. Gasoline f. Air nozzles g. Safety glass h. Chemicals (shop) i. Good work habits j. Emergency plans	Student discussion. Written assignment on laboratory policies.
E. Energy Conservation	Lecture Emphasize the most important areas of energy conservation: a. Turn off all electric equipment and lights when not in use. b. Close all doors and windows. c. Do not use excessive gasoline.	Student discussion. List steps which will conserve energy in the school and at home.

BLOCK TEN

DIAGNOSIS AND TUNE UP

- A. Use of Diagnostic Equipment
- B. Minor Tune Up
- C. Major Tune Up

BLOCK TEN
DIAGNOSIS AND TUNE UP

OBJECTIVES:

The student will develop the skill and knowledge necessary to perform properly all functions relating to tune up. Specifically the student will be able to:

- A. Demonstrate the use of diagnostic equipment.
- B. Demonstrate the sequence for minor tune up.
- C. Demonstrate the sequence for major tune up.

BLOCK TEN - - DIAGNOSIS AND TUNE UP

Topics of Instruction	Content/ Method	Student Activities
A. Use of Diagnostic Equipment	Lecture/Demonstration Introduction and explanation of various types and uses of diagnostic equipment: a. Timing devices b. Coil tester c. Tachometer d. Spark plug tester and cleaner e. Condenser tester f. Compression gauge g. Dynamometer and other related test equipment	Classroom discussion, reading assignments, note taking, and practice. Identify various types of diagnostic equipment and be able to demonstrate their proper use.
B. Minor Tune Up	Lecture/Demonstration Introduction and explanation of various equipment used and proper procedure to follow when performing minor tune ups: a. Troubleshooting ignition systems b. Ignition system service c. Fuel, oil, and air filter service d. Oil change and lubrication	Class discussion, note taking, and practice. Identify tune up equipment, demonstrate proper tune up procedure and explain each step in detail.
C. Major Tune Up	Lecture/Demonstration Introduction and explanation of various equipment used and proper procedure to follow when performing major tune ups: a. Ignition system 1) Test coil 2) Disassemble and repair magneto 3) Test electrical circuits	Class discussion, note taking, and practice. Demonstrate the proper procedure to follow and the various equipment used in performing major tune ups.

BLOCK TEN - - DIAGNOSIS AND TUNE UP (Continued)

Topics of Instruction	Content/ Method	Student Activities
C. Major Tune Up (Cont.)	b. Fuel system 1) Disassemble and clean carburetor 2) Adjust air fuel mixture on carburetor 3) Adjust carburetor and governor linkage c. Engine assembly 1) Test cylinder compression 2) Time engine 3) Check for engine wear	

BLOCK ELEVEN

POWER TRANSMISSION

- A. Types of clutches
- B. Method of power transmission

BLOCK ELEVEN

POWER TRANSMISSION

OBJECTIVES:

The student will develop the skill and knowledge necessary to perform properly power transmission fundamentals. Specifically, the student will be able to:

- A. Explain the operation of various assemblies.
- B. Explain the methods of power transmission.
- C. Identify the basic clutch parts and explain the purpose of each.
- D. Adjust power transmission systems.

BLOCK ELEVEN - - POWER TRANSMISSION

Topics of Instruction	Content/ Method	Student Activities
A. Clutches	Lecture/Demonstration Basics of clutches: a. Purpose b. Basic parts c. Types	Classroom discussion Study information sheets. Take notes. Identify the parts, give purpose for basic clutch types.
B. Methods of Power Transmission	Lecture/Demonstration The various methods of transmitting power: a. Direct b. Belt c. Friction d. Fluid e. Pneumatic f. Gear g. Chain drive	Classroom discussion and practice. Adjust various power transmission systems

BLOCK TWELVE

FLUID POWER

- A. Fundamentals
- B. Cylinders
- C. Valves
- D. Pumps
- E. Accessories
- F. Troubleshooting

BLOCK TWELVE

FLUID POWER

OBJECTIVES:

The student will develop understanding of and skill in fluid power application. Specifically, the student will be able to:

- A. Explain the fundamentals of fluid power.
- B. Explain the fundamentals of cylinders.
- C. Explain the fundamentals of valves.
- D. Explain the fundamentals of pumps.
- E. Explain the fundamentals of accessories.
- F. Explain the fundamentals of troubleshooting.
- G. Disassemble, inspect, and reassemble a hydraulic cylinder.
- H. Identify, disassemble, inspect, and assemble valves.
- I. Identify, disassemble, inspect, and assemble pumps.
- J. Identify, clean, and install various accessories.
- K. Diagnose problems, using proper procedures and equipment.

BLOCK TWELVE - - FLUID POWER

Topics of Instruction	Content/ Method	Student Activities
A. Fundamentals	Lecture/Demonstration Fundamentals of fluid power: a. Pascal's Law b. Effects of heat on fluids c. Compressibility of fluids	Classroom discussion and note taking. Written assignment on fluid power.
B. Cylinders	Lecture/Demonstration Fluid power transmitted through a cylinder	Classroom discussion and note taking. Disassemble, inspect, and reassemble a given hydraulic cylinder.
C. Control Valves	Lecture/Demonstration The classification of valves: a. Directional control b. Pressure control c. Accessory	Classroom discussion and note taking. Identify, disassemble, inspect, and assemble the various valves.
D. Pumps	Lecture/Demonstration How pumps convert mechanical energy to fluid power: a. Gear b. Piston c. Vane d. Gerotor	Classroom discussion and note taking. Disassemble, inspect, and assemble the various pumps.
E. Accessories	Lecture/Demonstration The use and importance of accessories: a. Hydraulic oil reservoir b. Oil level gauge c. Filters d. Strainers e. Air breathers	Classroom discussion and note taking. Identify, clean, and install various accessories.
F. Troubleshooting	Lecture/Demonstration Orient the student by following an organized procedure.	Classroom discussion, note taking, and practice. Diagnose problems using proper procedure and equipment.

BLOCK THIRTEEN
PNEUMATIC POWER

- A. Fundamentals
- B. Cylinders
- C. Valves
- D. Compressors
- E. Accessories
- F. Troubleshooting

BLOCK THIRTEEN
PNEUMATIC POWER

OBJECTIVES:

The student will develop understanding of and skill in pneumatic power application. Specifically, the student will be able to:

- A. Explain the fundamentals of pneumatic power.
- B. Explain the fundamentals of cylinders.
- C. Explain the fundamentals of valves.
- D. Explain the fundamentals of compressors.
- E. Explain the fundamentals of accessories.
- F. Explain the fundamentals of troubleshooting.
- G. Disassemble, inspect, clean, and assemble a compressor.
- H. Disassemble, inspect, and reassemble a pneumatic cylinder.
- I. Identify, disassemble, inspect, and assemble various valves.
- J. Disassemble, reassemble, and test operation of a compressor.
- K. Identify, disassemble and reassemble the various accessories.
- L. Diagnose problems using proper procedures and equipment.

BLOCK THIRTEEN - - PNEUMATIC POWER

Topics of Instruction	Content/ Method	Student Activities
A. Fundamentals	Lecture/Demonstration Basic fundamentals of pneumatic power: a. Use b. Compressor c. Tank and gauges d. Repair	Classroom discussion and note taking. Disassemble, inspect, clean, and assemble compressor.
B. Cylinders	Lecture/Demonstration How pneumatic power is transmitted through a cylinder.	Classroom discussion and note taking. Disassemble, inspect, and reassemble a given pneumatic cylinder.
C. Control Valves	Lecture/Demonstration The classification of valves: a. Directional control b. Pressure control c. Accessories	Classroom discussion and note taking. Identify, disassemble, inspect, and assemble various valves.
D. Compressors	Lecture/Demonstration How the various types of compressors convert mechanical energy into pneumatic power:	Classroom discussion and note taking. Disassemble, reassemble, and test operation of given compressors.
E. Accessories	Lecture/Demonstration The use and importance of accessories: a. Reservoir b. Gauges c. Filters d. Strainers e. Oilers	Classroom discussion and note taking. Identify, disassemble, and reassemble the various accessories.
F. Trouble-shooting	Lecture/Demonstration Orient the student by following an organized test procedure.	Classroom discussion, note taking, and practice. Diagnose problems using proper procedure and equipment.

BLOCK FOURTEEN
FACILITY MANAGEMENT

- A. Introduction and safety
- B. Management
- C. Estimating
- D. Layout

BLOCK FOURTEEN
FACILITY MANAGEMENT

OBJECTIVES:

The student will develop understanding of and skill in managing a power shop facility. Specifically, the student will be able to:

- A. Demonstrate principles of general and personal safety.
- B. Demonstrate leadership in safety education through safety committee functions.
- C. Demonstrate skills in business procedures and customer relations.
- D. Explain basic principles of advertising.
- E. Maintain shop records.
- F. Demonstrate the ability to make estimates.
- G. Explain principles of and demonstrate the ability to manage money.
- H. Demonstrate the ability to plan a power mechanics facility.

BLOCK FOURTEEN - - FACILITY MANAGEMENT

Topics of Instruction	Content/ Method	Student Activities
A. Introduction and Safety	Lecture/Demonstration Introduction to facility management and safety. The importance of shop safety: a. General safety b. Personal safety c. Safety committee	Classroom discussion and test. List precautions, demonstrate procedures and proper use. Pass a test on all aspects of shop safety.
B. Management	Lecture The importance of proper facility management technique: a. Business procedures b. Customer relations c. Advertising d. Records e. Miscellaneous	Classroom discussion and reading assignments. List the responsibilities of good management.
C. Estimating	Lecture Reasons for having a good working knowledge of the various estimating areas: a. Money management b. Income cash c. Labor rates d. Parts costs e. Expenses of the business f. Parts and equipment sales g. Profit and loss ratio	Classroom discussion, reading assignments, and practice. Written test on principles of estimating.
D. Layout	Lecture Explain the advantages of careful consideration given when designing and laying out a power mechanics facility.	Classroom discussion, note taking, and work assignment. Lay out and draw a floor plan for a power mechanics facility.

APPENDIX A

INSTRUCTIONAL AIDS

INSTRUCTIONAL AIDS

American Association for Vocational Instructional Materials
Engineering Center
Athens, Georgia 30602

SELECTING AND STORING FUELS and LUBRICANTS, Vol. 1 (M108),
58 Transparency Masters

MAINTENANCE AND REPAIR OF SMALL ENGINES, Vol. 2 (M109),
88 Transparency Masters

CARE AND OPERATION OF SMALL ENGINES, Vol. 1, (M108),
88 Transparency Masters

SELECTING AND STORING FUELS and LUBRICANTS, (S102),
58 2x2 Color Slides

CARE AND OPERATION OF SMALL ENGINES, Vol. 1 (S108),
193 2x2 Color Slides

MAINTENANCE and REPAIR OF SMALL ENGINES, Vol. 2 (S109),
329 2x2 Color Slides

Audio Fidelity Corporation
3032 Trinkle Avenue
Roanoke, Virginia 24012

MILLIKEN SHOP and HOME SAFETY SERIES, Transparency sets as follows:

TDT21 Personal Safety, 12 transparencies, 12 duplicating masters,
topics as follows:

Clothing and jewelry; eye protection; hot metal protection; foundry area; welding area safety equipment; ventilation; hair protection; respiration equipment; housekeeping during work; lifting heavy objects; the mouth, carrying tools.

TDT22 Using Hand Tools, Part 1, 16 transparencies, 12 duplicating masters; topics are as follows:

Hammer safety; using hammers; hammer faults; screwdrivers; reconditioning screwdriver blades; using a screwdriver; common misuses of screwdrivers; using rules and squares; using a combination set; use the right chisel -- metal; machinists' and cold chisels; use the right chisel -- wood; using wood chisels; procedures for boring; using metal cutting ships; misuses of snips.

TDT23 Using Hand Tools, Part 11, 16 transparencies, 12 duplicating masters; topics are as follows:

INSTRUCTIONAL AIDS (Continued)

TDT23 (continued)

Using pliers; long nose pliers; adjustable wrenches; fixed jaw wrenches; file safety; types of filing; using wood rasps; cleaning a file; hacksaws; selecting hacksaw blades; uses and misuses of hacksaws; using wood handsaws; misuses of wood handsaws; crosscut and rip saws; hand planes; hand planes -- use and storage.

Bergwall Productions, Inc.
Garden City, New York 11530

IGNITION SYSTEM EXPLAINED, No. 401

6 color film strips, 60 - 81 frames each/ 6 cassettes 12 - 17 min. each, plus study guide.

Topics are as follows:

1. Operation of basic parts
2. Distributor and timing mechanisms
3. Starting problems in primary circuit
4. Starting problems in secondary circuit
5. How to locate an engine miss
6. Use of electrical test equipment

THE INTERNAL COMBUSTION ENGINE EXPLAINED, No. 405

5 color filmstrips, 50 - 75 frames each/ 5 cassettes, 8 - 16 min. each, plus study guide.

Topics are as follows:

1. Basic parts and operation
2. Lubrication and valve operation
3. Carburetion, ignition and cooling
4. Valve problems, causes and corrections
5. How to do a valve job.

PROBLEMS OF THE INTERNAL COMBUSTION ENGINE EXPLAINED, No. 409

4 color filmstrips, 61-83 frames each/ 4 cassettes, 12 - 17 min. each, plus study guide.

Topics are as follows:

1. Compression leaks
2. Oil pressure problems
3. Excessive oil consumption
4. Unusual engine problems

INSTRUCTIONAL AIDS (Continued)

Bobs-Merrill Educational Publishing
4300 W 62nd Street
Indianapolis, Indiana 46206

FLUID POWER TRANSPARENCY MASTERS, Item No. 20592, 8½" x 11",
166 masters.

Also available in a set are:

Fluid Power Calculator, Fluid Power Instructor's Manual
and Student's Workbook.

DCA Educational Products
424 Valley Road
Warrington, Pennsylvania 18976

SMALL GAS ENGINE SERIES, Multicolored transparencies with overlays.
Can be purchased individually or as a complete set. Individual
titles are:

- T-1 The Four Stroke Cycle
- T-2 Operation of the Cross Flow Two-Stroke Engine
- T-3 Loop Scavenged Two-Stroke Engine Operation
- T-4 Reciprocating Engine Cylinder Arrangements
- T-5 Common Valve Arrangements
- T-6 Four Cycle Engine Cutaway
- T-7 Two Cycle Engine Cutaway
- T-8 Suction Feed Carburetor
- T-9 Diaphragm Carburetor with Diaphragm Fuel Pump
- T-10 Liquid Cooling System
- T-11 Air Cooling Systems
- T-12 V-8 Engine Lubrication System
- T-13 Constant Level Splash Lubrication System
- T-14 Updraft Float Feed Carburetor
- T-15 Horizontal Float Feed Carburetor (Tillotson)
- T-16 Spark Plug Design and Construction
- T-17 Operation of the Flywheel Magneto
- T-18 The Rotating Magnet Magneto

Several of the UNDERSTANDING THE AUTOMOBILE series can be used with
power mechanics classes. Individual titles are:

- UA 1 Understanding The Cooling System
- UA 2 Understanding The Lubrication System
- UA 3 Understanding The Ignition, Fuel and Exhaust System
- UA 4 Understanding The Electrical System
- UA 5 Understanding The Four-Stroke Engine

OUTBOARD MOTOR SERIES; individual titles are:

- OM 1 Terminology Part 1
- OM 2 Terminology Part 2

INSTRUCTIONAL AIDS (Continued)

DCA Products (Continued)

OUTBOARD MOTOR SERIES (Continued)

- OM 3 Two Stroke Cycle
- OM 4 Magneto Armature Plate Assembly
- OM 5 Spark Plug
- OM 6 Vacuum Fuel Pump
- OM 7 Reed Valves
- OM 8 Carburetor
- OM 9 Cooling System - - Water Pump
- OM 10 Cooling System (Thermostat-Recirculating)
- OM 11 Lower Units (Non-reversible)
- OM 12 Lower Units (Forward - Neutral - Reverse)
- OM 13 Outboard Installation
- OM 14 Propellers (Diameter and Pitch)
- OM 15 Propellers (Blade Angle)

PRECISION MEASUREMENT SERIES; individual titles are:

- PM-B 1 Principal Parts of a Micrometer
- PM-B 2 Micrometer Scale Gradations
- PM-B 3 Method of Holding a Micrometer
- PM-B 4 Depth Micrometer
- PM-B 5 Chamfer Micrometer
- PM-B 6 Calculating Diameter of a Chamfer
- PM-B 7 Calculating Depth of a Chamfer
- PM-B 8 Vernier Caliper
- PM-B 9 Vernier Caliper Gradations
- PM-B 10 Testing the Accuracy of Vernier Calipers
- PM-B 11 Center Vernier Caliper
- PM-B 12 Method of Using a Center Vernier
- PM-B 13 Vernier Depth Gauge
- PM-B 14 Transfer Height Gauge
- PM-B 15 Vernier Height Gauge, Scriber and Test Indicator
- PM-B 16 Knife Edge Vernier Caliper

ROTARY ENGINES SERIES; individual titles are:

- RE 1 Nomenclature
- RE 2 Basic Parts
- RE 3 Power Cycle
- RE 4 How Power Cycle Turns the Drive Train
- RE 5 Sealing the Rotor
- RE 6 Lubrication
- RE 7 Cooling
- RE 8 Typical Twin-Rotor Engine Electrical System
- RE 9 Carburetion and Induction
- RE 10 Emission Control
- RE 11 Twin-Rotor Automobile Engine
- RE 12 Comparison of Piston and Rotary Engines

INSTRUCTIONAL AIDS (Continued)

DCA Educational Products (Continued)

SAFETY MACHINE and POWER TOOLS SERIES. Individual titles are:

- SMP - 1 General Safety Rules 1
- SMP - 2 General Safety Rules 2
- SMP - 3 General Safety Rules 3
- SMP - 4 General Safety Rules 4

Educ-Tech. Publications
 Division of Commercial Service Co.
 P.O. Box 2499
 Anderson, Indiana 46011

FOUNDATIONS OF ELECTRICITY and MAGNETISMBATTERIESHIGH ENERGY IGNITION SYSTEMS

Training charts (26" x 36") Bound flip up charts (Manuals provided with charts)

ESB Brands, Inc.
 P. O. Box 6949
 Cleveland, Ohio 44101

HOW A STORAGE BATTERY WORKS, 18" x 24" chartPARTS AND ASSEMBLY OF A LEAD ACID STORAGE BATTERY, 18" x 24" chart

INSTRUCTIONAL AIDS (Continued)

General Motors Film Library
Public Relations Staff
General Motors Building
Detroit, Michigan 48200

ABC of HAND TOOLS

16 mm sound and color film.

ABC of the DIESEL ENGINE

16 mm sound and color film.

ABC of the GAS TURBINE

16 mm sound and color film.

METRES, LITRES and GRAMS

16 mm sound and color film.

OIL FILMS IN ACTION

16 mm sound and color film.

Ideal Pictures Film Library
4431 West North Avenue
Milwaukee, Wisconsin 53208

BIG NEW POWER IN LAND

16 mm sound and color film, 18 min.

John Deere Distribution Service Center
Department F
1400 Third Avenue
Moline, Illinois 61265

HYDRAULICS SLIDE SET, 200 slides covering the following topics:

Basic Principles	Basic Systems
Pumps	Valves
Cylinders	Motors
Accumulators	Filters
Reservoirs	Coolers
Hoses	Pipes and Tubes
Seals	Fluids
Maintenance	Troubleshooting

HYDRAULICS TRANSPARENCY MASTER SET, 150 masters with folder, covers
the same areas listed above.

INSTRUCTIONAL AIDS (Continued)

John Deere Distribution Service Center

ELECTRICAL SYSTEMS SLIDE SET, 295 slides covering the following topics:

Basic Principles	Ignition Circuits
Basic Circuits	Lighting Circuits
Testing Equipment	Accessory Circuits
Storage Batteries	Maintenance
Charging Circuits	Troubleshooting
Starting Circuits	Terms and Symbols

ELECTRICAL SYSTEMS TRANSPARENCY MASTER SET, 190 masters with folder, covers same areas listed above.

ENGINES SLIDE SET, 300 slides covering the following topics:

Basic Theory	Lubrication Systems
Types of Engines	Cooling Systems
Uses of Engines	Governing Systems
Basic Engine Services	Test Equipment
Gasoline Fuel Systems	Service Tools
LP-Gas Fuel Systems	Diagnosis and Testing
Diesel Fuel Systems	Tune-Up
Intake and Exhaust Systems	Glossary

ENGINES TRANSPARENCY MASTER SET, 200 masters with folder, covers same topics listed above.

POWER TRAINS SLIDE SET, 195 slides covering the following topics:

Basic Principles	Torque Converters
Clutches	Differentials
Mechanical Transmissions	Final Drives
Hydraulic Assist Transmissions	PTO's
Hydrostatic Drives	Special Drives

POWER TRAINS TRANSPARENCY MASTER SET, 130 Masters with folder, covers same topics listed above.

Kohler Company
Kohler, Wisconsin 53044

"ON TARGET" TRAINING KIT. Cranking systems, charging systems, vertical crankshaft systems, dynamics balance systems. Kit contains the following:

One set of 28 35mm slides; 21 slide program manuals;
15 flip charts; 21 flip chart manuals.

INSTRUCTIONAL AIDS (Continued)

Megatech Corporation
29 Cook Street
Billerica, Massachusetts 01866

SET OF TEN MEGATECH 4 CYCLE ENGINE SOUND FILMSTRIPS. Item No. MP2-AUT

This is a complete set of sound filmstrips which are designed to be used with the Megatech Transparent Internal-Combustion Engine and the Megatech Electric Dynamometer/Generator. A list of the ten filmstrips follows:

MP2-AV1	Introducing the Megatech MARK III Engine
MP2-AV2	Parts of 4 Cycle Engines
MP2-AV3	Principles of 4-Cycle Engines
MP2-AV4	How to Measure Horsepower
MP2-AV5	Megatech Electric Dynamometer, Model DGI
MP2-AV6	Measuring Horsepower with Different Fuels
MP2-AV7	Timing of a 4-Cycle Engine
MP2-AV8	Effects of Fuel/Air Ratio and Manifold Pressure
MP2-AV9	Operating Features of Carburetors
MP2-AV-0	Measuring Fuel/Air Ratio and Efficiency

SET OF 18 SMALL GAS ENGINES TRANSPARENCIES. Item No. MPZ-SGE

The transparencies to be of multicolor and with overlays wherever applicable. The set includes 18 transparencies as follows:

T-1	The Four-Stroke Cycle; 1 transparency, 6 colors
T-2	Operation of the Cross-Flow Two-Stroke Engine; 1 transparency, 4 colors
T-3	Loop-Scavenged Two-Stroke Engine Operations; 1 transparency, 6 colors
T-4	Reciprocating Engine Cylinder Arrangements; 1 transparency, 4 colors
T-5	Common Valve Arrangements; 1 transparency, 3 colors
T-6	Four-Cycle Engine Cutaway; 1 transparency
T-7	Two-Cycle Engine Cutaway; 1 transparency, w/1 overlay, 4 colors
T-8	Suction-Feed Carburetor; 1 transparency, 5 colors
T-9	Diaphragm Carburetor with Diaphragm Fuel Pump; 1 transparency, w/2 overlays, 8 colors
T-10	Liquid Cooling System; 1 transparency, 2/1 overlay, 5 colors
T-11	Air-Cooling System; 1 transparency, 4 colors
T-12	V-8 Engine Lubrication System; 1 transparency, 3 colors
T-13	Constant Level Splash Lubrication System; 1 transparency, w/2 overlays, 8 colors
T-14	Updraft Float-Feed Carburetor (Briggs); 1 transparency, w/2 overlays; 8 colors
T-15	Horizontal Float-Feed Carburetor (Tillotson); 1 transparency w/2 overlays, 8 colors

INSTRUCTIONAL AIDS (Continued)

Megatech Corporation (Continued)

SET OF 18 SMALL GAS ENGINES TRANSPARENCIES (Continued)

- T-16 Spark Plug Design and Construction; 1 transparency, 4 colors
- T-17 Operation of the Flywheel Magneto; 1 transparency, 6 colors
- T-18 The Rotating Magnet Magneto; 1 transparency, 6 colors

DIESEL ENGINE TRANSPARENCY. Item No. T-13-1. Single transparency in four colors showing major components.

ROTARY ENGINE TRANSPARENCY SET. Item No. 40RET. Explains and illustrates in the simplest terms how and why a Rotary Engine works:

- RE-1 Nomenclature; 5 colors, 1 overlay
- RE-2 Basic Parts; 5 colors, 1 overlay
- RE-3 Power Cycle; 17 colors, 3 overlays
- RE-4 How Power Cycle Turns the Drive Train; 6 colors, 2 overlays
- RE-5 Sealing the Rotor; 6 colors, 1 overlay
- RE-6 Lubrication; 5 colors, 1 overlay
- RE-7 Cooling; 6 colors; 2 overlays
- RE-8 Typical Twin-Rotor Engine Electrical System; 5 colors, 1 overlay
- RE-9 Carburetion and Induction; 6 colors, 1 overlay
- RE-10 Emission Control; 4 colors
- RE-11 Twin-Rotor Automobile Engine (Cutaway Drawing); 6 colors, 1 overlay
- RE-12 Comparison of Piston and Rotary Engines; 5 colors

RBI Corporation
959 Myers Street
Richmond, Virginia 23230

TURNOVER CHARTS: COMPRESSION CHARTS: COMPRESSION, CARBURETION, and IGNITION.

20" x 24" wall charts (a booklet entitled General Theories of Operation accompanies the charts.)

INSTRUCTIONAL AIDS (Continued)

RBI Corporation (Continued)

MOUNTED COLOR SLIDES, Individual Titles as follows:

- Set #3 Resizing Cylinder, 11 slides
- Set #5 Bearing Replacement, 12 slides
- Set #7 Start, Stop and Store, 28 slides
- Set #20 Checking Carburetor, 15 slides
- Set #24 Valves and Seats, 15 slides
- Set #42 Trouble Shooting, 38 slides
- Set #43 Disassembly, Inspect, Reassembly, 64 slides

Rexnord Inc.
Hydraulic Components Division
Technical Training Department
Racine, Wisconsin 53401

FLUID POWER COORDINATED PAMPHLET/SLIDE SERIES: Individual titles are

- Basic Hydraulics
- Introduction to Hydraulics
- Booster
- Circuits
- Directional Control Valves
- Hydraulic Fluids (Petroleum, Fire Resistant) S-106, S-107
- Hydraulic Piping, Tubing, Fittings and Seals
- Liquid Flow
- Package Units
- Power Units
- Pressure Controls
- Radial Piston Pumps, S-114
- Vane Pumps
- RA Repair Procedure, S-101
- FA Repair Procedure, S-100
- K Repair Procedure, S-102
- T Repair Procedure, S-103
- SV10 Repair Procedure, S-118
- SV20 Repair Procedure, S-117
- SV40 Repair Procedure, S-120
- SV80 Repair Procedure, S-119

Union Oil Company of California
Union 76 Division
Press and Public Relations Department
200 E. Golf Road
Palatine, Illinois 60067

WHO'S WHO IN THE ZOOTHE STORY OF OIL

Charts on oil and oil drilling
(assorted publications on oil included)

INSTRUCTIONAL AIDS (Continued)

Universal Education and Visual Arts
 A Division of Universal City Studios
 100 Universal City Plaza
 Universal City, California 91608

SMALL ENGINE OVERHAUL, No. 8080, set of 10 color loops

A step-by-step sequence of disassembling a small engine. Emphasis is also placed on marking parts for re-installation in the proper position.

8081	Removing the Flywheel
8082	Cylinder Head Removal
8083	Removing the Valves
8084	Disassembling the Engine
8085	Removing the Piston
8087	Piston Ring Removal
8088	Preparing the Piston for Installation
8089	Installing the Piston
8090	Installing the Valves
8091	Checking the Cylinder Bore
8092	Honing the Cylinder

SERVICING THE SMALL GASOLINE ENGINE, No. 7960, set of 10 color loops.

This series shows how to service and repair the small engine, how to test components, use tools and equipment, and tune and adjust for peak performance.

7961	The Air Cleaner
7962	Oil and Fuel
7963	The Spark Plug
7964	Removing Ignition Points
7965	Installing Ignition Points
7966	Replacing the Spark Plug Wire
7967	Carburetor Disassembly
7968	Carburetor Assembly
7969	So Your Engine Won't Start
7970	The Magneto

INSTRUCTIONAL AIDS (Continued)

Womack Educational Publications
 2010 Shea Road
 P. O. Box 35027
 Dallas, Texas 75235

INDUSTRIAL FLUID POWER, Color Slides

216 slides, 35mm, coordinated with Volume 1, Industrial Fluid Power.

216 slides, 35mm, coordinated with Volume 2, Industrial Fluid Power.

216 slides, 35mm, coordinated with Volume 3, Industrial Fluid Power.

Slides for Practical Fluid Power Control - Electrical and Fluidic

216 slides for Electrical section of book
 65 slides for Fluidic section of book

Champion Spark Plug Company
 P. O. Box 910
 Toledo, Ohio 43661

16 mm Color Films

Champion Spark Plug Motorcycle Classics (motorcycle racing)

Expedition to Columbia Icefields (snowmobile)

Glory Road

Number 1 (motorcycle racing)

A Plug for Performance (facts on spark plugs)

The Spark Plug (how and why of spark plug design)

APPENDIX B

EXAMPLE OF A UNIT GUIDE
BLOCK 4, THE FOUR CYCLE ENGINE

Description of the Unit Guide

The unit guide which follows will serve as an example of the preparation needed for teaching the various units of instruction. The teacher should develop unit guides for each block in the curriculum guide. Lesson plans are included for selected lessons only and a completed unit guide should contain a lesson plan for each lesson listed in the block breakdown. Teachers should develop their own content. The lesson plans included in this section are intended to serve only as examples.

Note that the teaching aids section on each lesson plan lists a coding. This is recommended as an easy method of identifying audio-visual materials, i.e., (A) movies (B) transparencies (C) film loops, etc. The teacher should develop a personal system of identifying materials. The codes shown on the lesson plans are fictitious, meant only to provide an example.

The approach for the unit guide is suggestive only, and the teacher may elect to develop a different format.

UNIT GUIDE

COURSE : POWER MECHANICS

BLOCK NO. 4

TITLE: FOUR CYCLE ENGINE

UNIT OBJECTIVES

Upon completion of this unit the student will be able to:

- A. Disassemble, inspect, and repair governor and component parts of the fuel system.
- B. Explain the function and components of the lubrication system.
- C. Disassemble, inspect, and repair component parts of the ignition and starter system.
- D. Inspect, clean, and repair various components of the cooling system.
- E. Locate and interpret manufacturer's specifications.
- F. Explain and demonstrate engine tune up.
- G. Explain and demonstrate proper troubleshooting sequence.
- H. Explain and demonstrate how to recondition properly a given engine block assembly.

LESSON TITLES FOR BLOCK 4

UNIT TITLE: THE FOUR CYCLE ENGINE

Doing Lessons	Knowing Lessons
How to:	
D4-1 Repair Fuel Systems and Governors	K4-1 Design Differences Between the Two and Four Cycle Engines
D4-2 Lubricate the Four Cycle Engine	K4-2 Fuel Systems and Governors
D4-3 Disassemble, Inspect and Repair the Ignition and Starter System	K4-3 Engine Lubrication
D4-4 Inspect, Clean and Repair Various Components of the Cooling System	K4-4 Ignition and Starting Systems
D4-5 Tune up the Four Cycle Engine	K4-5 The Cooling System
D4-6 Recondition Engine Block Assembly	K4-6 Manufacturer's Specifications
	K4-7 Engine Tune up
	K4-8 Troubleshooting Techniques

TEACHING AIDS

1. Books

Stephenson, George E. Small Gas Engines, Albany, New York:
Delmar Publishers, Chapters 3 - 6.

Roth, Alfred C., and Ronald J. Baird. Small Gas Engines, South
Holland, Illinois: Goodheart-Willcox Co., Inc.

2. Manuals, Pamphlets

1. MP2- Learning the Parts of the 4-Cycle Engine (Learning Package, Megatech)
2. MP2-JM4 Operating Principles of 4-Cycle Engines (Learning Package, Megatech)
3. Kohler 4 Cycle Engine Master Manual
4. MS-3553 General Theories of Operation, (Briggs & Stratton)
5. MS-4750 Repair Instructions (Briggs & Stratton)
6. MS 3222 Repair Manual (Briggs & Stratton)
7. MP 200C Four Cycle Engine Manual (Megatech)

3. Audio Visuals

Film: Air Cooling Systems (Kohler)

Transparencies:

- | | | |
|----|--|----------------------------|
| T1 | The Four Stroke Engine | |
| T4 | Reciprocating Engine Cylinder Arrangements | |
| T5 | Common Valve Arrangements | |
| T6 | Four Cycle Engine Cutaway | (DCA Educational Products) |

Slide Set:

Engines (John Deere)

"On Target" Training Set (Kohler)

Film Strip:

Fuel Systems: Principles and Operation (Ford)

Chart:

Auto Fuel System (Delco Remy)
Basic Engine Tune up (Delco Remy)

Transparency set:

Lubrication (Megatech)

Film:

Story of Petroleum (Sun)

UNIT 4 - FOUR CYCLE ENGINES

SUGGESTED METHOD OF APPROACH

The following method of approach for teaching this course unit is suggestive only; however, if you have had little experience in teaching the content of this unit, it is advisable that you follow the approach in detail for your first teaching. As you gain experience, new ways to demonstrate and make information topics dynamic will come to you and these should be recorded in the spaces between the steps in the teaching approach. The teaching approach below will run from the first to the last day of the unit. You will have to decide how much to cover each day the class meets.

SUGGESTED TEACHER APPROACH

STUDENT ACTIVITY

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Preliminaries (20 min) <ol style="list-style-type: none"> A. Check students for supplies B. Check lockers C. Safety inspection D. Check assembly and dis-assembly chart 2. Design differences between the two cycle and four cycle engines. (K4-1) | <ol style="list-style-type: none"> 1. Classroom assembly <ol style="list-style-type: none"> A. Roll call B. Safety test C. Safety report 2. <ol style="list-style-type: none"> A. Observe cut-away engine of the two cycle design and point out the reed valve assembly tracing the air-fuel flow through the induction system to the cylinder. B. Observe cut-away engine of the four cycle design and explain the intake and exhaust valve function tracing the air-fuel flow through the induction system to the cylinder. C. List parts of a four cycle engine which are not present or needed for operation of a two cycle engine. D. List and explain the advantages of the two cycle engine. E. List and explain the advantages of the four cycle engine. F. Describe situations where a two cycle engine design is desirable. G. Describe situations where a four cycle engine design is desirable. |
|---|---|

UNIT 4 - FOUR CYCLE ENGINES

SUGGESTED METHOD OF APPROACH (Continued)

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
3. <u>Fuel Systems and Governors</u> (K4-2)	3A. Disassemble, clean, inspect, adjust, and reassemble a typical four cycle carburetor assembly.
<u>Repair Fuel Systems and Governors</u> (D4-1)	3B. Disassemble, clean, inspect, reassemble and adjust a typical four cycle governor assembly.
	Chart: <u>Auto Fuel System Chart</u> . (Delco Remy)
	Film: <u>ABC of the Internal Combustion Engine</u> (GMC)
	Filmstrip: <u>Fuel Systems: Principles of Operation</u> (Ford)
4. <u>Engine Lubrication</u> (K4-3)	4A. Disassemble, inspect, and explain the oil flow by locating all oil passages of a typical four cycle engine.
<u>Lubrication of the Four Cycle Engine</u> (D4-2)	4B. Explain differences between the internal lubrication of the two cycle and four cycle engine design.
	Transparency set: <u>Lubrication</u> (Megatech)
	Film: <u>Story of Petroleum</u> (Sun)
5. <u>Ignition and Starting Systems</u> (K4-4)	5A. Properly install, lubricate and adjust a typical breaker assembly to manufacturer's specifications.
<u>Disassemble, Inspect and Repair the Ignition and Starter System</u> (D4-3)	5B. Remove, test, and reinstall a typical condenser assembly.
	5C. Remove, test, and reinstall a typical coil and secondary lead assembly to manufacturer's specifications.
	5D. Test flywheel magnets and install flywheel on engine to proper torque specifications.
	5E. Properly clean, inspect, and install a typical spark plug to manufacturer's specifications.

UNIT 4 - FOUR CYCLE ENGINES

SUGGESTED METHOD OF APPROACH (Continued)

SUGGESTED TEACHER APPROACH

STUDENT ACTIVITY

5. (continued)

Film: Ignition & Spark Plugs (Champion)Film: Story of Modern Storage Battery
(Electric Storage Battery Co.)Film: Story of Modern Spark Plug (Champion)

Chart: Basic Engine Tune-up (Delco Remy)

6. The Cooling System (K4-5)
Inspect, Clean and Repair Various Components of the Cooling System (D4-4)

6A. Explain the theory and operation of the cooling system of a typical air cooled four-cycle engine and contrast this with a water cooled version.

6B. Remove blower shroud assembly, inspect, clean, and reassemble all components of the unit to proper operating condition.

Slide series: Cooling System Diagnosis and Light Repair (Ford)Film: Air Cooling Systems (Kohler)

7. Engine Overhaul (Mechanical)

Recondition Engine Block
Assembly (D4-6)7A. Demonstrate ability to disassemble, clean, inspect, and correctly install necessary parts to restore an engine with a malfunction to acceptable operating condition, including work on:
1. valve train
2. crankshaft, connecting rod, and piston assembly
3. engine bearings
4. block assembly
5. lubrication system
6. engine timing (mechanical)8. Manufacturer's Specifications
(K4-6)

8A. Properly select correct manufacturer's specifications for a variety of engines.

8B. Demonstrate ability to adjust:
1. Coil heel clearance
2. Breaker point assembly
3. Governor assembly
4. Valve assembly - intake and exhaust
5. Carburetor high and low speed controls
6. Manual and electric starter assemblies

UNIT 4 - FOUR CYCLE ENGINES

SUGGESTED METHOD OF APPROACH (Continued)

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
8. (Continued)	Transparency set: Kit OM4 and 5 Tune up (DCA)
9. <u>Engine Tune Up (K4-7)</u> <u>Tune-up the Four Cycle Engine (D4-5)</u>	9A. Demonstrate ability to tune up properly a variety of four cycle engines to manufacturers' specifications including replacement and correct adjustment of components of: 1. the ignition system 2. the fuel system 3. engine accessories
10. <u>Troubleshooting Techniques (K4-8)</u> <u>Recondition Engine Block Assembly (D4-6)</u>	10A. Demonstrate ability to trouble shoot: 1. Fuel system and choke assembly 2. Ignition system - Primary and secondary 3. Governor controls 4. Lubrication system 5. Valve train 6. Engine Compression 10B. Demonstrate ability to trouble shoot such customer complaints as: 1. Engine will not start. 2. Engine starts but will not continue to run. 3. Engine starts and continues to run, but will not develop power. 4. Engine starts and runs but misfires. 5. Engine starts cold but will not start hot. 6. Engine vibrates while running. 7. Engine smokes while running. 8. Engine continually surges during operation. 9. Engine knocks during operation. 10. Engine rattles during operation.
	Slide series: Sets #3, #5, #43 (Briggs & Stratton)

LESSON PLANS
FOR UNIT 4

INSTRUCTOR'S LESSON PLAN
Related Technical Information

BLOCK FOUR
Lesson K4-2

SUBJECT: Fuel Systems and Governors

AIM: The student will be able to explain the use and operation of fuel systems and governors.

TEACHING AIDS: E-2, A-10, C-LA, B-8 Briggs & Stratton Manual

MATERIALS: Special tools, governor assembly, carburetor, fuel filter, air filter, injector and injector pump

REFERENCES: Stephenson, Small Gas Engines (Delmar)

I. PREPARATION (of the learner)

1. Impress upon the student the importance of proper tool layout.
2. Know the parts of the fuel systems and governors for good dis-assembly.
3. Importance of parts cleanliness.
4. Importance of having the proper tools for the job
5. Will have to know for test following lesson.
6. Importance of proper safety.

II. PRESENTATION (of the information)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
1. Fuel filter service	1. a. Service at proper intervals b. Proper sequence for removal and installation of fuel filters c. Adds to engine life
2. Air cleaner service	2. a. Ways of determining when to clean or replace air filter b. Importance of air filter c. Adds to engine life
3. Carburetion	3. a. Supplies proper fuel air mixture to engine b. Types of carburetors

II. PRESENTATION (of the information) (Continued)

INSTRUCTIONAL TOPICS	Things to remember to do or say
4. Purpose of governors	4.a. Keeps engine speed constant b. Keeps engine speed in operating range
5. Types of governors	5 a. Mechanical b. Air vane/pneumatic
6. Servicing governors	6.a. Adjustment of speed b. Cleaning of pivot pin, linkage and arm
7. Injector pump	7.a. Purpose of injector pumps b. Precaution to follow while making adjustments and repairs c. Importance of pump timing
8. Injectors	8.a. Purpose of injectors b. Removing injectors from engine c. Cleaning and servicing injectors d. Injector installation
9. Use of special tools	9.a. Care of special tools b. Feel gauges c. Pressure gauges d. A.B.C's of hand tools book
10. Ask questions	10. a. Components of the fuel system b. Materials constructed of c. Purpose of the carburetor d. Purpose of fuel; air filters e. Name of special tools f. Parts of the carburetor g. Purpose and parts of injector pumps
11. Summary	

III. APPLICATION

1. Have students disassemble carburetor, assemble, and adjust carburetor.
2. Test and adjust injector pump.
3. Remove and replace oil and air filters.

IV. TEST

Quiz on work covered.
Performance test

Suggested Readings for Student:

Pages 76 - 82, text

INSTRUCTOR'S LESSON PLAN
Related Technical Information

BLOCK FOUR
Lesson K-4-3

SUBJECT: Engine Lubrication

AIM: The student will explain the lubrication process of the four cycle engine.

TEACHING AIDS: Overhead projector

MATERIALS: C5, A-12, E-4, A-13 Briggs and Stratton Manual

REFERENCES: Stephenson, Small Gas Engines (Delmar)

I. PREPARATION (of the learner)

1. Impress upon the student the importance of lubricating various parts of the four cycle engine.
2. Know the purpose of lubrication.
3. Know the types of lubricants used.

II. PRESENTATION (of the information)

INSTRUCTIONAL TOPICS		THINGS TO REMEMBER TO DO OR SAY
1.	Purpose of lubrication	How proper lubrication prolongs engine life. a. Cooling action b. Cleaning action c. Sealing action
2.	Types of lubricants	a. Detergent oils b. Non-detergent oils c. Various lubricating grease
3.	Types of systems	3 a. Oil slinger b. Oil dipper c. Oil pumps
4.	Discussion	4 a. When to use detergent oils b. When to use non-detergent oils c. How oil slingers work d. How oil dippers work e. Adjusting oil pump discharge pressure
5.	Summary	

III. APPLICATION

1. Have students identify various types of lubricants.
 2. Know difference between splash lubrication and forced feed lubrication.
-

IV. TEST

1. Suggest quiz on work covered.
 2. Performance test.
-

Suggested reading for students: Pages 82-85 (text)

INSTRUCTOR'S LESSON PLAN
Related Technical Information

BLOCK FOUR
Lesson K4-4

SUBJECT: FOUR CYCLE ENGINE IGNITION AND STARTING SYSTEM

AIM: The student will explain system and demonstrate necessary repairs.

TEACHING AIDS: A-15, E-5, A-11, E-6, C-9, Briggs and Stratton Manual

MATERIALS: Proper tools, testing equipment, and parts.

REFERENCES: Stephenson, Small Gas Engines, (Delmar)

I. PREPARATION (of the learner)

1. Explain need for special tools.
2. Explain need for correct diagnostic equipment.
3. Provide references and specification manuals.
4. Explain safety rules to student with reference to ignition and starter.

II. PRESENTATION (of the information)

INSTRUCTIONAL TOPICS		THINGS TO REMEMBER TO DO OR SAY
1. Function of the ignition circuit	1a.	Explain various ignition circuits
2. Ohm's Law	2a.	Describe rules of electricity 1. Electrical pressure 2. Resistance
3. Types	3a.	Discuss 1. Heat of compression (Diesel) 2. Mechanical distributors 3. Solid state
4. Magnetism	4a.	Explain what part magnetism plays in the electrical starter and mechanical driven distributors.
5. Component parts	5a.	Explain use of following parts: 1. Coil 2. Resistor 3. Points 4. Wiring

 II. PRESENTATION (of the information) (Continued)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
6. Mechanical Starters	6a. Discuss: 1. Kick starter 2. Rewind starter 3. Wind-up starter 4. Starter pulley (rope wind) 5. Hand crank
7. Electrical starter	7a. Explain 1. Battery starters, 6 and 12 volts 2. 110 a.c. starter 3. Combination starter generator

 III. APPLICATION

1. Diagrams, cutaways, flip charts, films.

 IV. TEST

1. Written test on starter systems
 2. Written test on ignition systems
 3. Performance test
-

Suggested Reading for Student:

Library assignment will be made

INSTRUCTOR'S LESSON PLAN
Related Technical Information

BLOCK FOUR
Lesson K 4-5

SUBJECT: The Cooling System

AIM (or purpose): The student will explain the operation of the four cycle engine

TEACHING AIDS: D-1, A-16, Briggs and Stratton Manual

MATERIALS:

REFERENCES: Stephenson, Small Gas Engines, (Delmar)

I. PREPARATION (of the learner)

1. Impress upon the students the importance of engine cooling.
2. Familiarization with the shrouding parts for easy disassembly and assembly.
3. Understanding the various components of the water cooled system.
4. Knowledge of how to drain or remove a radiator cap safely.
5. Protecting the water cooled engine from freezing.
6. Understanding the various components of the air-cooled system.
7. Understanding the function and operation of blower components.
8. Understanding the effect of temperature on engine wear.

II. PRESENTATION (of the information)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
1. Types of cooling systems	1. a. Air cooled b. Water cooled
2. Purpose of engine cooling	2. a. Dissipates heat caused by combustion b. Prevents engine part failure c. Maintains operating temperature

II. PRESENTATION (continued)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
3. Periodic servicing and maintenance	3. a. Check blower and shroud b. Check water level in radiator using proper safety procedure c. Keep fins clean d. Demonstrate proper procedure for removing and replacing thermostat
4. Nomenclature and care of air cooled engine cooling system components	4. a. Exercise care in tightening fasteners in aluminum castings b. Cracking of shroud assembly due to loose fasteners c. Engine balancing problems resulting from broken cooling fins
5. Nomenclature and care of water cooled engine cooling system components	5. a. Exercise care in handling tools near the radiator b. Exercise care in attachment of coolant hoses c. Exercise care with pressurized cooling systems d. Drive belt testing and attachment
6. Air and water cooled engine thermostats	6. a. How to identify various thermostats b. How to test various thermostats
7. Preventing the water cooled engine from freezing	7. a. Types of antifreeze b. Purpose of antifreeze c. Function of antifreeze d. Testing of antifreeze
8. Special equipment required for servicing water cooled engines	8. a. Cooling system pressure tester b. Thermostat tester c. Pressure cap tester
9. Ask questions	9. Review for lesson test
10. Summary	10. Relate material in this lesson to the next lesson

III. APPLICATION (drills, illustrations, analogies, oral questions or assignments)

1. Have students identify the various parts of the air-cooled cooling system.
 2. Have students identify the various parts of the water-cooled cooling system.
-
-

IV. TEST (final check on students' comprehension of material presented)

Test on engine cooling system.

Suggested Reading for student:

The next lesson is: Manufacturer's Specifications

INSTRUCTOR'S LESSON PLAN
Related Technical Information

BLOCK FOUR
Lesson K 4-6

SUBJECT: Manufacturer's Specifications

AIM: The student will be able to read and understand specifications or measurements supplied by engine manufacturers.

TEACHING AIDS: E-7, C-10, A-7, Opaque projector

MATERIALS: Engine nameplates

REFERENCES: Engine specification manuals from Briggs and Stratton, Kohler, Megatech

I. PREPARATION (of the learner)

Explain the purpose of manufacturer's specification manuals and the importance of adhering to specifications while repairing any make or model of engine. Specifications are supplied by the engineers and manufacturers of engines to give us measurements to follow in all repairs.

II. PRESENTATION (of the information)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
1. Torque of bolts (foot pounds)	1. Never exceed torque specification
2. Bearing clearances	2. Plasti-gauge, shim stock
3. Pistons	3a. Check ring groove wear b. Measure skirt of piston c. Piston pin clearance d. Condition of crown e. Never use wire brush on piston skirt f. Proper use of ring groove cleaner g. Balance of piston h. Put piston back in same cylinder i. Pistons are cam ground
4. Piston Rings	4a. End clearance b. Groove clearance c. Thickness of rings d. Placement of rings

II. PRESENTATION (of the information) (continued)

- | | |
|--------------------|---|
| 5. Crankshaft | 5a. Main journal diameter
b. Rod journal diameter
c. End play
d. Taper
e. Out of round
f. Out of balance |
| 6. Valve Train | 6a. Diameter of stem
b. Diameter of head
c. Angle of face
d. Angle of seat and width
e. Margin
f. Tappets and lifters
g. Push rods
h. Rocker arms
i. Rocker shaft
j. Ball stud service
k. Valve guide
l. Valve spring
m. Tappet clearance |
| 7. Camshaft | 7a. Alignment
b. Bearing journals
c. Lobes
d. End play |
| 8. Cylinder Blocks | 8a. Cylinder wear
b. Cleaning and inspecting
c. Bearing-bore checks |

NOTE: Never use gasoline as a cleaning agent.

III. APPLICATION

Have students use various manufacturer's specification manuals. Look up and discuss specifications on different makes and models of engines.

IV. TEST

Have students list all specifications necessary during block overhaul for specific engine types.

Suggested reading: Text, Chapters 6, 7, 8, 17, 18, 19

INSTRUCTOR'S LESSON PLAN
Related Technical Information

BLOCK FOUR
Lesson K 4-7

SUBJECT: Engine Tune-up

AIM (or purpose): The student will explain the process of the various tune-up instruments.

TEACHING AIDS: A-17

MATERIALS: Various tune-up instruments, special tools.

REFERENCES: Stephenson, Small Gas Engines, (Delmar)

I. PREPARATION (of the learner)

1. Impress upon the student the proper care and handling of special tools and instruments in four cycle engine tune-up.
2. Proper ignition system tune-up procedure for any given engine.
3. Proper fuel system tune-up procedure for any given engine.
4. Disassembly and assembly procedure.
5. Use of tune-up instruments.
6. The relationship of proper tune-up procedures to customer relations.
7. Proper tune up vs. business reputation.
8. Safety procedures to follow during tune-up work.

II. PRESENTATION (of the information)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
1. Tune-up instruments	1. a. Explain the importance of using the proper tools and instruments during engine tune up. b. Demonstrate the proper use of tune-up equipment. c. Impress upon the student the importance of proper care and maintenance of tune-up equipment. d. Explain the importance of good tune-up safety.

II. PRESENTATION (continued)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
2. Engine tune-up	2. a. Explain the importance of proper and regular tune-up. b. Explain proper engine tune-up procedure. c. Point out means of recognizing faulty component parts.
3. The ignition system both standard and solid state	3. a. Importance of obtaining correct specifications. b. Always select correct replacement components. c. Always properly test each component part prior to replacement.
4. The fuel system including introduction to fuel injection	4. a. Importance of obtaining correct specifications. b. Always select correct replacement components. c. Always test air filter system and fuel filters prior to any carburetor work. d. Always adhere to manufacturer's specifications during carburetor overhaul.
5. Disassembly and reassembly	5. a. Stress the importance of keeping all parts in strict order. b. Stress the importance of keeping a neat clean work area.
6. Tune-up instruments	6. a. Always calibrate all test equipment. b. Keep test leads away from rotating components of the engine.
7. Customer relations	7. a. Building a sound reputation. b. Maintaining a sound reputation. c. Advertisement.
8. Safety	8. a. Stress safety during all operations. b. Safety films. c. Safety test.
9. Ask questions	9. Review for lesson test.

II. PRESENTATION (continued)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
10. Summary	10. Relate material in this lesson to the next lesson.

III. APPLICATION (drills, illustrations, analogies, oral questions, or assignments)

Have students demonstrate proper use and care of tune-up equipment and tools during routine service and tune up of various makes of engines.

IV. TEST (final check on students' comprehension of material presented)

Written test on material concerned

Tune-up competition

Suggested Reading for Student:

The next lesson is: Troubleshooting

INSTRUCTOR'S LESSON PLAN
Related Technical Information

BLOCK FOUR
Lesson K 4-8

SUBJECT: Troubleshooting Techniques

AIM: The student will explain an elimination process for engine tune-up.

TEACHING AIDS: One four-cycle engine, test equipment and appropriate flip charts, E-3

MATERIALS: Blackboard and chalk

REFERENCES: Owner's Manuals; Stephenson, Small Gas Engines (Delmar)

I. PREPARATION (of the learner)

Explain the importance of troubleshooting and the advantages of being able to determine the source of difficulty before starting repairs.

Emphasize time factor.

II. PRESENTATION (of the information)

INSTRUCTIONAL TOPICS		THINGS TO REMEMBER TO DO OR SAY
1.	Will not start	1a. Check compression b. Check ignition system c. Check fuel system
2.	Engine starts then stops	2a. Fuel tank vent b. Clogged air breather c. Clogged fuel line or filter d. Sticking carburetor needle valve e. Ignition coil f. Ignition points and condenser g. Sticking valves
3.	Overheating	3a. Air inlet screen and blower b. Clogged radiator c. Water pump d. Collapsed hoses e. Clogged water jacket f. Stuck thermostat g. Lean fuel mixture h. Timing i. Improper lubrication

 II. PRESENTATION (of the information) (continued)

INSTRUCTIONAL TOPICS	THINGS TO REMEMBER TO DO OR SAY
4. Engine surges while running	4a. Improper carburetor adjustment b. Improper governor adjustment c. Worn linkage d. Vacuum leaks e. Hole in fuel line

 III. APPLICATION

Use diagrams, flip charts, and various test equipment to assist in troubleshooting

 IV. TEST

Written test on troubleshooting

Troubleshooting assignment

INSTRUCTOR'S LESSON PLAN
Related Technical Information

BLOCK FOUR
Lesson D 4-1

LESSON TITLE: How to Repair and Service Fuel Systems and Governors

AIM: The student will be able to repair and service fuel systems and governors

TOOLS and EQUIPMENT: Four-cycle engines

MATERIALS

TEACHING AIDS: E-2, A-10, C-4, B-8, Briggs & Stratton manual

REFERENCES: Stephenson, Small Gas Engines (Delmar)

I. PREPARATION (of the learner)

1. Lay out necessary special tools.
2. Have necessary disassembly charts
3. Lay out necessary technical manuals.

II. PRESENTATION (of the skills)

STEPS	THINGS TO REMEMBER TO DO OR SAY
1. Remove, inspect, and replace fuel filter.	1a. Show different types of fuel filters.
a. Remove wing nut (if applicable)	b. Location of fuel filter.
b. Remove filter	c. Discuss importance of fuel filter gasket.
c. Install new filter, check for gasket	
d. Replace wing nut	
2. Remove, clean, or replace air filter	2a. Show different types of air filters.
a. Remove wing nut	b. Location of air filter
b. Remove filter	c. Importance of air tight seal around filter.
c. Inspect filter, clean or replace	
d. Install filter	
e. Replace wing nut	
3. Remove, disassemble, repair, clean, and replace carburetor.	3a. Show different types of carburetors.
	b. Demonstrate proper disassembly procedures.
	c. Show various adjusting screws

 II. PRESENTATION (of the skills) (continued)

STEPS	THINGS TO REMEMBER TO DO OR SAY
4. Disassemble, clean, and assemble governor assembly	4a. Stress the importance of cleanliness. b. Demonstrate proper disassembly procedure. c. Demonstrate various adjustments. d. Demonstrate various types of speed governing devices.
5. Remove, disassemble, clean and replace injector pump	5a. Show various types of injector pumps b. Stress the importance of cleanliness. c. Show importance of timing injector pump.
6. Remove, clean, and replace injector	6a. Demonstrate removal procedure b. Impress upon the students the importance of keeping the injector clean. c. Proper procedure for replacing injector.
7. Identify various special tools and their proper uses	7a. Show the importance of having the proper tools for a given job.

NOTE: Reference all discussion to proper service manuals.

 III. APPLICATION

Assign student to various aforementioned jobs.
 Follow procedure until all students have completed each operation.

 IV. TEST

Inspect work of each student on completion of operation.
 Grade each student on his/her work, using a checklist.

INSTRUCTOR'S LESSON PLAN
Manipulative Skills

BLOCK FOUR
Lesson D 4-3

LESSON TITLE: How to Disassemble, Inspect, and Repair the Ignition and Starter System

AIM: The student will be able to repair properly the ignition and starter systems

TOOLS AND EQUIPMENT: Timing light, feeler gauges, Grouler test lamp

MATERIALS: Electrical starter, distributors

TEACHING AIDS, Chalkboard, chalk, charts, transparencies, overhead projector.

REFERENCES: Text

I. PREPARATION (of the learner)

- Lay out necessary tools, and instruction manuals.
- Lay out correct testing equipment.
- Discuss tools, test equipment used by the mechanic.
- Explain purpose for using instruction manual, and how to use it.
- Explain the role of the mechanic.

II. PRESENTATION (of the skills)

STEPS		THINGS TO REMEMBER TO DO OR SAY
1.	Remove distributor, clean, inspect, repair, and replace	1a. Instruct student the correct way to: a. Install points and condenser. b. Check for short circuits. c. Measure condenser capacity. d. Inspect vacuum and electrical advance units. e. Set ignition timing.
2.	Identify basic types of ignition systems	2a. Explain the purpose and basic types of ignition systems.
3.	Trace ignition current flow from battery to spark plug	3a. Explain the sequential current flow in ignition systems.

II. PRESENTATION (of the skills) (continued)	
STEPS	THINGS TO REMEMBER TO DO OR SAY
4. Identify component parts of various ignition systems	4a. Explain the function of each component part. b. Stress the importance of cleanliness. c. Explain the importance of using the proper tools for a given job. d. Explain safety procedure to follow while making checks and repairs to ignition systems.
5. Identify various types of starters	5a. Explain the difference between the electric and mechanical starter. b. Have students disassemble, clean, repair, and assemble an electric starter. c. Have students disassemble, inspect, and assemble a recoil starter. d. Demonstrate procedure for rewinding starter spring.

III. APPLICATION

1. Assign students to various above-mentioned jobs.
2. Follow procedure until all students have completed each application.

IV. TEST

1. Check each student's work upon completion of each operation.
2. Written performance on material covered.

INSTRUCTOR'S LESSON PLAN
Manipulative Skills

UNIT FOUR
Lesson D 4-6

LESSON TITLE: How to Recondition Engine Block Assembly

AIM: The student will demonstrate proper sequence and process in reconditioning engine block assembly.

TOOLS AND EQUIPMENT: Students' hand tool sets, and special tools from tool room

MATERIALS: One four-cycle engine

TEACHING AIDS: Handouts of disassembly and assembly sheets prepared by instructor

REFERENCES: Stephensen, Small Gas Engines (Delmar)

I. PREPARATION (of the learner)

Show the students how to recondition an engine block and explain the savings of reconditioning over the purchase of new engines.
Review safety factors.

II. PRESENTATION (of the skills)

STEPS	THINGS TO REMEMBER TO DO OR SAY
1. Disassemble	1. Disassembly
a. Disconnect spark plug wires	a. Prevents damage to plugs and wires
b. Drain fuel system (small engines) tanks, lines, carburetor	b. Prevents fire hazards
c. Drain oil from crankcase	c. Observe condition of oil
d. Remove air cleaner	d. Observe condition of air cleaner
e. Remove carburetor	e. Use line wrench to disconnect line
f. Remove air shrouding (air cooled)	f. Use care to prevent damage
g. Remove flywheel	g. CAUTION! Do not drop
h. Remove rocker covers, rocker arms, and push rods	h. Observe dents, alignment, and wear
i. Remove cylinder head	i. Observe condition of combustion chamber, valves, and gasket surfaces
j. Remove oil pan	j. Inspect for alignment and damage
k. Remove cylinder ridge	k. Explain importance of removing ridge CAUTION: Do not cut more than necessary
1. Remove piston assembly	1. CAUTION: Care should be used to prevent rod bolts from scarring crank pin

 II. PRESENTATION (of the skills) (continued)

STEPS	THINGS TO REMEMBER TO DO OR SAY
1. Disassemble (continued)	
m. Remove crankshaft	m. Protect machined surfaces
n. Remove camshaft and tappets	n. Inspect bearing surfaces, cam lobes and condition of tappets.
2. Inspect, measure and replace all defective parts	
3. Reassemble, using reverse of disassembly sequence.	

 III. APPLICATION

Each student will recondition an engine during the school year.

 IV. TEST

Grade each student's performance.
Record on progress chart.

SUGGESTED
LABORATORY MANAGEMENT MATERIALS
FOR UNIT 4

PRODUCTION ACTIVITY RATING SHEET

Date _____
 Dept. _____ Rated by instructor _____
 Student to be rated _____ Year in Grade _____ Class _____
 Date discussed with student _____
 Previous rating _____

INSTRUCTIONS: Rate student on the basis of the actual work he/she is now doing in shop activity. Listed below are six factors on which he/she is to be rated. Keep these clearly in mind and read definitions very carefully. Each factor has a rating from low (1) to high (10). Your evaluation of one factor should not influence the evaluation of another factor.

<u>Superior</u>				
<u>EMOTIONAL STABILITY</u> Consider his/her emotional response to class activities				
10				
Exceptionally stable	Well-balanced	Unusually well-balanced	Hyper-emotional	Apathetic
<u>ATTITUDE TOWARD SUPERVISION</u> Consider his/her cooperation with authority				
10				
Highly co-operative	Very dependable	Usually co-operative	Reluctant to cooperate	Difficult to handle
<u>ABILITY TO LEARN</u> Consider the ease of learning new methods and instructions				
10				
Superior, has to be told only once	Learns with ease	Ordinary, needs normal amount of follow-up	Learns fairly well. A little slow	Requires repeated instruction
<u>QUALITY OF WORK</u> Consider over-all craftsmanship to department standards				
10				
Exceptionally accurate	Good, accurate work, seldom makes mistakes	Work usually correct, some errors, could be neater	Quality and accuracy below standard	Considerable waste; slipshod work
<u>PRODUCTIVITY</u> Consider department standards to volume of work produced				
10				
High production, uses time to good advantage	Usually steady worker Produces above average	Produces normal requirements, normal supervision	Production somewhat below normal. Just enough to get by	Nearly always behind
<u>SAFETY</u> Consider his/her safe working practices and inspiring safety to others				
10				
Constant attention to safety, promotes safety	Usually alert to hazards, considers safety of others	Normally safe	Takes unnecessary chances, some horse-play	Accident prone. A hazard to himself and others

SPECIFIC COMMENTS:

CLASS PROCESS CHART

UNIT # 8 IGNITION SYSTEM

School _____
 Class POWER MECHANICS I
 Instructor E. Trainum
 Date _____

	DISASSEMBLE Flywheel	Magneto Plate	REASSEMBLE Flywheel	Magneto Plate	REPLACED High tension coil	Breaker points	Retimed engine	Used diagnostic equipment	SERVICE Carburetor	Governor	Lubrication system	Valves	Engine Accessories	INSTALL Valve Lifters	Cam Shaft	Int. & Ex. Valve	Crankshaft	Connecting Rod	Piston Rings	Cylinder Head	Trouble shoot	Fuel System	Ignition System	Engine Accessories
BOWLES, G.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BERRY, D.	Y	X	X	X	X	X	/		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BROWN, D.	X	X	X	/	X	X	X	O	X	O	X	O	X	X	X	X	X	X	X	X	X	X	X	X
CARPENTER, G.	X	X	X	X	X	X	X	X	O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DINKIN, A.	X	/	X	O	O	Y	O	O		O	X	X	X	X	X	X	X	X	X	X	X	X	X	X
GRAYSON, C.	X	X	X	X	X	X	X	X																
JOHNSON, G.	X	X	X	/	O	X	X	O																
FRANKLIN, J.	X	X	X	X	X	X	X	X																
POWER, D.	X	X	X	X	X	X	X	X																
WARD, V.	X	X	X	X	X	X	/	O																
WOODWARD, T.	X	X	X	X																				

O = not ad-
 vanced
 enough

/ = half
 complete

Y = 3/4
 complete

X = complete

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SAFETY SUPERVISOR'S UNSAFE PRACTICES WEEKLY REPORT

Trade _____ Area _____ Week Beginning _____

NAME	List Unsafe Act and Date It Occurred
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	

WISE COUNTY VOCATIONAL SCHOOL
WISE, VIRGINIA

SAFETY MEETING WORK SHEET

1. Safety topic to be discussed _____

2. List resource material to be used _____

3. Attendance

Student number (circle if present at meeting)

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20				

4. Date / / 19 a.m. p.m. (circle one)

5. Review and list accidents for the past month _____

6. Safety committee members for past month _____

7. Safety committee members for the coming month _____

Signed: Safety Supervisor _____

Instructor _____

WEEKLY WORK PERFORMANCE

To Be Turned In Each Friday

Week Ending _____

MONDAY

1. Period _____
2. Period _____
3. Period _____

TUESDAY

1. Period _____
2. Period _____
3. Period _____

WEDNESDAY

1. Period _____
2. Period _____
3. Period _____

THURSDAY

1. Period _____
2. Period _____
3. Period _____

FRIDAY

1. Period _____
2. Period _____
3. Period _____

Additional Information _____

Instructor's Comments _____

Upon my honor, the information given is true to the best
of my knowledge.

Signed: _____

RUSSELL COUNTY VOCATIONAL SCHOOL
LEBANON, VA.

ABSENTEE RECORD

Date _____

Electricity II

	Mon.	Tues	Wed.	Thurs.	Fri.
1. Terry Addington					
2. Audrey Artrip					
3. Marvin Cain		Absent			
4. John Fuller					
5. George Grizzle			Excused		
6. Ella Holbrook		Signed by student			
7. Billy Johnson					
8. Betty Johnson					
9. David Kiser		Tardy			
10. Susan Plaster			Unexcused		
11. John Porter					
12. Wilma Sempel					
13. Randall Smith					

Having students sign in on an absentee record eliminates any argument later on. This is especially important when graduation from the program is dependent on hours. A progress chart is used in conjunction with this record.

INSTRUCTION SHEETS
FOR UNIT 4

POWER MECHANICS JOB SHEET

DISASSEMBLY OF THE VALVES

GENERAL INFORMATION:

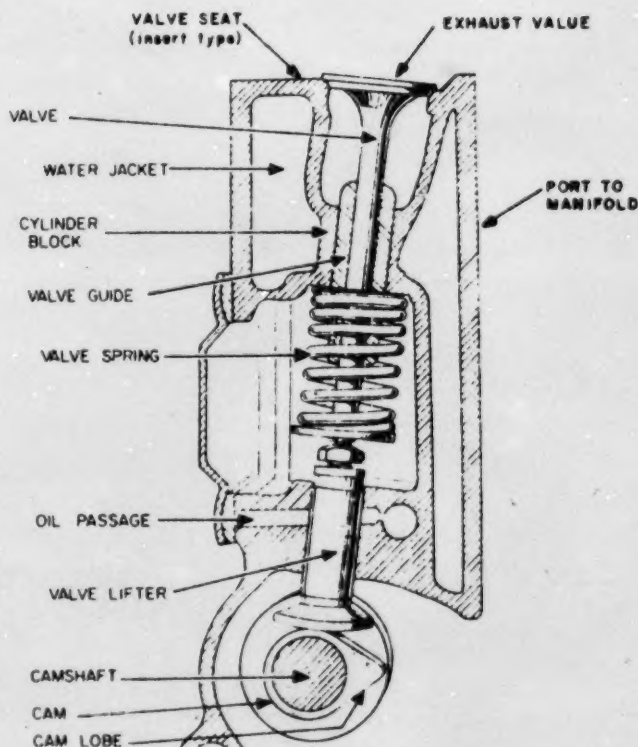
1. Almost all small gasoline engine valves are removed and replaced in the same manner.
2. The air shrouding, carburetor, cylinder head, inspection plate must be removed to disassemble the valves and valve train. (On some engines the gas tank must also be removed).
3. ALL SAFETY PRECAUTIONS WILL BE CARRIED OUT:
 - A. All spilled gas will be wiped up.
 - B. Safety glasses will be worn when using spring compressor.
 - C. Tools will be kept orderly.
 - D. No more than TWO persons will work together at one time.
 - E. Valve grinder will not be used without permission from the instructor. (Safety glasses will be used while grinding valves).
- D. There will be no HORSE PLAY in shop.

4. Tools and Equipment:

- | | | |
|-----------------------------|------------------------|-----------------|
| 1. Tool box complete. | 3. Valve Seat Remover. | 5. Feeler Gage. |
| 2. Valve Spring Compressor. | 4. Valve Grinder. | 6. Shop Rags. |

5. PROCEDURE:

- A. After all necessary parts are removed.
 - a. Take and record intake valve air gap reading. .008" of an inch.
 - b. Take and record exhaust valve air gap reading. .009" of an inch.
 - c. Check valve faces for excessive wear and burning.
 - d. Check exhaust valve for same.
- B. Select the right size valve spring compressor for size of valves.

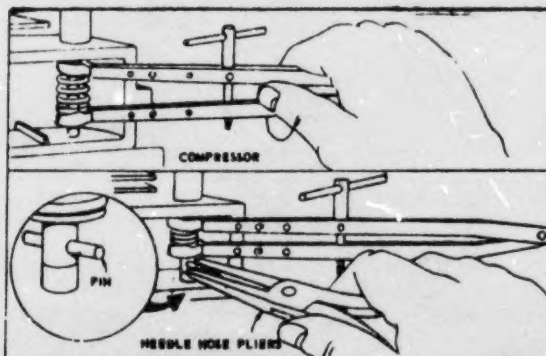


DISASSEMBLY OF VALVES

REMOVING VALVE SPRING USING SPECIAL SPRING COMPRESSION

VALVE STEPS

VALVE SPRING



- C. Turn spring compressor to correct opening so that ends of compressor will slide over to spring and under spring washer.
- D. Compress spring using "T" screw on compressor, (turn clockwise). Compress spring until retainers are free to drop out, or retainer pin can be removed.
- E. Use needle nose pliers to remove retainers for inspection chamber.
CAUTION: DO NOT LET RETAINER PINS FALL INTO CRANKCASE THROUGH OIL DRAINS.
NOTE: If this should happen the crankcase cover will have to be removed to recover pins.,
- F. Lift valve from cylinder block.
- G. Remove spring compressor and spring from inspection chamber.
CAUTION: DO NOT LET SPRING SLIP FROM SPRING COMPRESSOR WHILE REMOVING FROM INSPECTION CHAMBER.
- H. Inspect valve face for excessive wear and burning.
- I. Inspect valve seat for excessive wear and burning.
- J. Check valve stems for excessive wear.
Note: Reinsert valve in valve guide after cleaning valve stem. Check for excessive "play."
- K. Test spring tension with tester, if available.
- L. Check that all parts are in a good container and CLEAN.

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HOW TO TAKE RING END AND SIDE CLEARANCE AIR GAP READINGS

OBJECTIVE

1. How to determine correct ring end air gap.
2. How to read piston ring side clearance.

INTRODUCTION

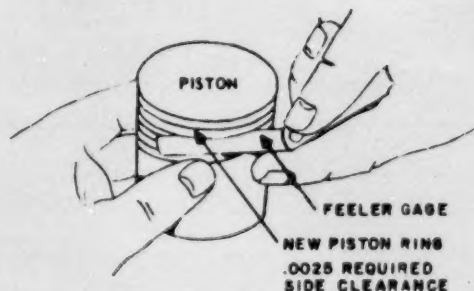
Improper ring end and side clearances ruin the engine in a very short time if the clearances are not correct. If the rings have no room for expansion, increase of engine temperature causes excessive pressure on cylinder walls.

Tools

One tool box complete with special tools for readings.

PROCEDURE

1. TO TAKE PISTON RING END AIR GAP READINGS.
 - A. Remove old rings and check for excessive wear in spots to determine cylinder out-of-round condition.
 - B. Clean cylinder walls and rings to be replaced.
 - C. Insert new ring in cylinder and push down by reversing piston. (push in about 1/2")
 - D. Use formula: Diameter of piston top X .004" (diameter 3" X .004" = .012")
 - E. Reading should be taken with engine cold.
 - F. Hold feeler gage at a straight angle.
 - G. Check manual for reading.

SIDE CLEARANCE

2. TO TAKE PISTON RING SIDE CLEARANCE.
 - A. Install new rings in piston grooves.
 - B. Read between piston groove and ring as shown in diagram.
 - C. Reading for most small engines would be .0025" for the top ring or power ring, and .003" for the wiper and compression ring.
 - D. There is no formula for these readings. If the ring end air gap is correct the side clearance will also be correct.
 - E. Make sure there is no dirt between the piston ring and the ring grooves.

POWER MECHANICS ASSIGNMENT SHEET

1. Read unit No. 7 in Stephenson, pages 84 to 100.
2. Study arrangement of ignition parts.
3. Work three problems, finding voltage drop, resistance, and amperes flowing in circuit.

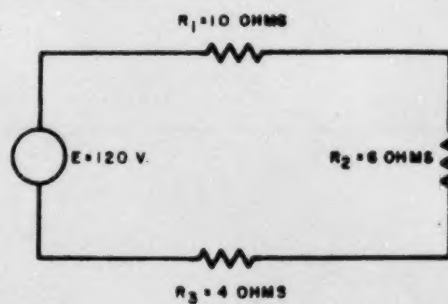
$$E = I \times R$$

$$I = \frac{E}{R}$$

$$R = \frac{E}{I}$$

4. Find voltage drop across each resistor in schematic A

$$\begin{aligned} \text{Total Resistance} = R_t &= R_1 + R_2 + R_3 \\ &= R_t \end{aligned}$$



Schematic A

5. Draw schematic of magneto plate and its components.
6. Set breaker points air gap reading using T/A.
7. Practice engine timing procedures steps.
8. Inspect various breaker points and pick out the best ones.
9. Study notes for test Friday.

POWER MECHANICS INFORMATION SHEET

POWER MECHANICS 1

Description of
Electrical Parts in the MAGNETOOBJECTIVES

1. To learn the magneto parts.
2. Describe the overall electrical schematic.
3. Describe uses of magneto parts.

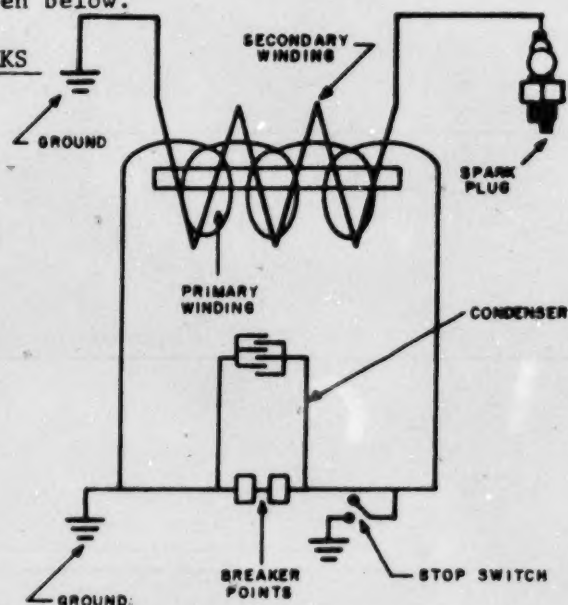
INTRODUCTION

1. It is necessary to understand the function of parts and how they operate as one unit. Study the schematic given below.

HOW IT WORKS

1. Secondary windings to spark plug carrying 20,000 volts. Grounded to engine frame.
2. Primary winding, produces first voltage to magnetize the iron core. Carries only low voltage, breaker points, condenser, and stop switch all connected to primary windings. All parts grounded to engine frame.
3. Soft IRON CORE holds its magnetism only while primary winding is energized. It is a temporary magnet.
4. Condenser, connected across breaker points, prevents points from burning and stores up electricity, discharges into primary winding for an electrical charge.
5. Breaker points open and close the primary winding, causing a build up and collapsing of the magnetic field, generating a high voltage in the secondary windings. Opening and closing of breaker points starts the firing procedure for spark ignition.
6. Stop switch grounds out primary winding so that voltage cannot be produced in the primary winding. As a result magnetism for voltage generation cannot be produced.
7. ALL PARTS ARE GOUNDED TO ENGINE FRAME:

a. Secondary winding	d. Condenser
b. Primary winding	e. Stop Switch
c. Breaker points	



Ground Symbol

POWER MECHANICS JOB PLAN

JOB TITLE Ignition System

Study the blueprint and make out a bill of material. Check the order of procedures to be followed. List the material to be used for each operation. Compile a list of tools to be used and record actual time required in doing each operation. Log all readings taken while setting the timing. Check with your instructor before starting.

BILL OF MATERIAL

Parts No.	Part Description	Manufactured by	Cost
30548A	Condenser	Briggs and Stratton	\$ 1.35
30560	Coil Assembly	" " "	7.35
40547A	Breaker Points	" " "	2.87

Total Cost \$11.57

TIMING AND ASSEMBLY STEPS

Steps	Operation	Tools to be used	Setting	Condition	Time
1	Replace breaker cam	None	None	Good	5 mins.
2	Replace magneto plate	4" Screw driver	Flywheel	Fail	20 mins.
3	Condenser	4" Screw driver	None	Replaced	20 mins.
4	Breaker Points	4" Screw driver Feeler gage	.020"	Replaced	35 mins.
5	Flywheel	1/4" Socket	None	Good	30 mins.

Approved by Instructor _____ Student _____

EXAMINATION

FOR UNIT 4

This Unit 4 examination is included only as an example. Hopefully, it will serve as an aid to the teacher in the test development process.

EXAMINATION POWER MECHANICS

Part 1: MULTIPLE CHOICE

DIRECTIONS: Each of the following questions are incomplete statements listed below and followed by several words, phrases, or series of numbers. Choose the one that answers the question or completes the statement correctly. Simply circle the letter of that word or phrase (A, B, C, D, or E) that is correct.

EXAMPLE: X. Which of the following is a type of nut?

- A. Cone
- B. Oval
- ☒ C. Hex
- D. Fluted
- E. Flat

1. Which of the following is not a wrench?
 - A. Open end
 - B. Spanner
 - C. Combination
 - ☒ D. Phillips
 - E. Crescent
2. Which of the wrenches listed below is adjustable?
 - A. Box wrench
 - ☒ B. Crescent
 - C. Open-end
 - D. Combination
 - E. Ratchet
3. Which is not a part of a micrometer?
 - A. Frame
 - B. Spindle
 - C. Anvil
 - ☒ D. Head
 - E. Barrel
4. Pliers are used primarily for
 - A. turning a screwdriver when removing a tight screw
 - B. holding chisels and punches
 - ☒ C. bending, shaping, and holding metallic materials in place
 - D. holding bolt heads that are loose
 - E. loosening nuts that are not too tight
5. Which of the following is not a stroke of the four cycle engine?
 - A. Compression
 - B. Exhaust
 - ☒ C. Ignition
 - D. Power
 - E. Intake

6. The small gasoline engine is classified as a (an)
 - ☒ A. heat engine since heat is a form of power
 - B. engine with a rated horsepower for small jobs
 - C. engine which is cooled by air
 - D. engine which is used mostly on lawn mowers
 - E. engine which operates on gasoline instead of diesel fuel
7. The engine is fitted with a round opening called the
 - A. piston guide wall
 - B. shaft that contains the piston
 - ☒ C. cylinder of the block
 - D. power cylinder of the block
 - E. combustion chamber
8. Which of the following statements would best describe the purpose of the crankshaft?
 - A. It is constructed of a very hard steel
 - ☒ B. It converts reciprocating motion into a useful rotary motion
 - C. It is constructed to withstand the force of the power stroke
 - D. It contains the connecting rod, flywheel and a power take-off
 - E. It must be timed with the camshaft for the four cycle engine
9. Which of the statements below would least describe the camshaft?
 - ☒ A. It opens and closes the exhaust and intake valves
 - B. It opens but does not close the exhaust and intake valves
 - C. It is driven by the crankshaft
 - D. It has cams which are sometimes called "lobes"
 - E. It has one revolution for every two of the crankshaft
10. Which of the engine parts are known as "doors"?
 - A. Exhaust and intake valve inspection plate
 - B. The engine crankcase cover and gasket
 - ☒ C. Exhaust and intake valves
 - D. The cylinder head
 - E. Exhaust and intake opening for the two cycle engine
11. Which part would not be in the valve train?
 - A. Valve key
 - B. Valve spring
 - C. Valve guide
 - ☒ D. Valve margin
 - E. Valve lifter
12. For an engine which will not start, the first check should be
 - A. the tightness of the flywheel for good ignition
 - B. the fuel mixture to the combustion chamber
 - C. the spark in the primary winding
 - D. cleanliness of the gasoline tank
 - ☒ E. the spark at the spark plug

13. A two (2) cycle engine does not have a (an)
A. reed valve
☒ B. oil ring
C. diaphragm carburetor
D. piston deflector
E. a poppet valve
14. The two cycle engine is lubricated by
☒ A. oil added to the fuel
B. oil added to the crankcase
C. a pump that is operated by the operator
D. an oil pump in the crankcase
E. the simple splash system
15. Which part listed below is not part of a typical fuel system for small gasoline engines?
A. Fuel pump
B. Gasoline tank
C. Carburetor
D. Fuel line
☒ E. Air cleaner
16. The pressurized fuel system is used mostly for engines
☒ A. which operate at very high speeds
B. used on outboard motor boats
C. in which the gasoline tank is some distance from the engine
D. of the two (2) cycle class
E. which have a diaphragm carburetor
17. To do a complete valve grinding job one would need to remove the
A. gasoline tank, carburetor, cylinder head, valve inspection cover and shrouding
B. flywheel, carburetor, cylinder head, valve inspection plate and shrouding
☒ C. cylinder head, shrouding, gasoline tank, valve inspection
D. crankcase cover, cylinder head, shrouding, valve inspection plate and flywheel
E. shrouding, cylinder head, flywheel, valve inspection plate and carburetor
18. Which of the five lubricating systems would be used least on small gasoline engines?
A. simple splash
B. constant level splash
☒ C. ejection pump
D. barrel-type pump
E. full pressure system

19. The oil slinger type of lubrication is operated by the
- A. connecting rod movement
 - B. drive gear on the crankshaft
 - C. cams on the camshaft
 - D. drive gear on the camshaft
 - ☒ E. crankcase pressure
20. Bearing friction is best described by the movement of the
- A. crankshaft main bearing
 - B. cams on camshaft moving lifters
 - C. connecting rod on the crankshaft
 - ☒ D. lower main crankshaft bearing
 - E. piston movement in the cylinder
21. The best grade of oil would be
- A. MM for services typical of small gasoline engines
 - B. M1 for two cycle engines
 - C. MS for severe uses
 - D. multigrade oils DM
 - ☒ E. detergent oils D
22. For the magneto ignition system, which part is not on the assembly plate of a magneto system unit?
- A. Permanent magnet
 - B. Temporary magnet
 - ☒ C. Condenser
 - D. High tension coil
 - E. Breaker points
23. What part of the magneto ignition system is not connected into the primary winding?
- ☒ A. Stop switch
 - B. Condense
 - C. Spark plug
 - D. Breaker points
 - E. Common ground
24. If the engine continued to exhaust dark smoke after adjusting the carburetor, this would indicate that the
- A. pistons were worn
 - B. oil needs changing
 - ☒ C. choke is closed
 - D. air filter is dirty
 - E. throttle valve stuck open

Part II. Completion of statements

Directions: Fill in the word or words which will make the statement complete in the blank provided at left of statement. DO NOT FILL IN BLANK AT THE END OF THE STATEMENT.

- | | |
|------------------------|---|
| <u>.010 of an inch</u> | 25. A piston ring end air gap reading for an engine with a cylinder bore of 2.5 inches should be _____. |
| <u>deflector</u> | 26. The Cross Flow engine piston has a design crown which gives it a _____. |
| <u>ohms</u> | 27. The amount of resistance in an electrical circuit is read in _____. |
| <u>voltage</u> | 28. The letters EMF indicate the electromotive force in an electrical circuit and is read in _____. |
| <u>eddy currents</u> | 29. The permanent and temporary magnets are laminated to reduce the _____. |
| <u>fulcrum pin</u> | 30. The pin which the movable side of the breaker point pivots on is called the _____. |
| <u>frame</u> | 31. All electrical components of the magneto ignition system has a common ground that is connected to the engine _____. |
| <u>hand cranked</u> | 32. The impulse coupling is used on engines with two or more cylinders which can be electrically started or _____. |
| <u>vacuum</u> | 33. Most automatic spark advance systems used on engines with four or more cylinders is the _____ type. |
| <u>gravity</u> | 34. When the engine is not running, the pawls in the impulse coupling are held open so they will strike the stop pin by the force of _____. |

Problem or situation statements:

DIRECTIONS: The following are problem or situations which you may encounter while repairing small gasoline engines. Solve the problem and put your answer in the blank provided at left.

- | | |
|-----------------|---|
| <u>5.5 amps</u> | (SAMPLE) An electrical circuit has a total resistance of 20 ohms and 110 volts, the ampere flowing in circuit would be: |
|-----------------|---|

- 55 ohms 35. An electrical circuit has three (3) resistors in it. They have values of 5 ohms, 20 ohms, and 30 ohms, all connected in series. The total resistance would be:
- 45 volts 36. Rt in an electrical circuit is 15 ohms with a current flow of 3 amps, the voltage in the circuit would be:
- 72 teeth 37. The engine's crankshaft drive gear has a total of 36 teeth. From this you know that the camshaft driving gear would have:
- 16 38. If you traveled 280 miles and used 17.5 gallons of gasoline, the mileage per gallon is:
- 88 39. A 10 inch hack saw has 32 teech per inch. The total number of teeth for 1/4 of the blade would be:
- 840 volts 40. A step-up transformer has a ratio of 3:1. What would be the secondary voltage if the primary was 280 volts?

Identification

DIRECTIONS: Listed below are several abbreviations of piston position in the cylinder. Write the proper meaning in the blank provided.

SAMPLE:	Horsepower	HP
<u>Before top dead center</u>	41.	BTDC
<u>Top dead center</u>	42.	TDC
<u>Revolutions per second</u>	43.	RPS
<u>Society of Automotive Engineers</u>	44.	SAE

Part IV. Matching Items:

DIRECTIONS: Indicate the proper disassembly of a Briggs-Stratton engine crankshaft model #142434. Match the sequence step numbers from the right hand column with the parts part to be disassembled in the left hand column. Some of the steps listed are unnecessary for this disassembly. (15 pts.)

PARTS TO BE DISASSEMBLED:

STEP NUMBERS

<u>6</u>	45. Flywheel	1
<u>3</u>	46. Air Shrouding	2
<u>1</u>	47. Spark Plug	3
<u>5</u>	48. Air Screening	4
<u>13</u>	49. Crankshaft	5
<u>8</u>	50. Cylinder Head	6
<u>7</u>	51. Braker Cam	7
	52. Valve Key	8
<u>9</u>	53. Crankcase Cover	9
<u>10</u>	54. Camshaft	10
	55. Valve Springs	11
<u>11</u>	56. Connecting Rod Cap	12
<u>2</u>	57. Gasoline Tank	13
<u>4</u>	58. Carburetor	14
<u>12</u>	59. Piston	15

Matching Items

DIRECTIONS: Match the engine parts in the right hand column with the engine components in the left hand column. Some parts listed in the right hand column will not be used.

<u>W</u>	X Flywheel (SAMPLE)	V. Venturi
		W. Key (correct)
		X. Contact
<u>D</u>	60. Spark Plug	A. Stop Pin
<u>F</u>	61. Valve Train	B. Flywheel
<u>A</u>	62. Impulse Coupling	C. Margin
<u>E</u>	63. Governor	D. Electrode
<u>H</u>	64. Carburetor	E. Pneumatic
<u>B</u>	65. Cooling System	F. Lifters
<u>G</u>	66. Lubrication	G. Viscosity
<u>C</u>	67. Valve	H. Diaphragm
<u>J</u>	68. Starter	I. Drive Gear
		J. Pulley
		K. Ports

Continue matching questions.

Engine troubleshooting matching questions:

DIRECTIONS: Match the possible cause in the right hand column with the engine problems in the left hand column.

ENGINE PROBLEMS:

- | | |
|----------|-----------------------------------|
| <u>E</u> | 70. Engine exhausting dark smoke |
| <u>D</u> | 71. Engine speed fluctuating |
| <u>A</u> | 72. Weak spark |
| <u>B</u> | 73. Engine overheats |
| <u>C</u> | 74. Fails to start |
| <u>J</u> | 95. Knocking sound from crankcase |
| <u>K</u> | 96. Blow-back through carburetor |
| <u>G</u> | 97. Breaker points burnt |
| <u>H</u> | 98. Blue exhaust smoke |

POSSIBLE CAUSE:

- | | |
|----|--------------------|
| A. | Condenser |
| B. | Fins dirty |
| C. | Stop switch |
| D. | Governor mechanism |
| E. | Fuel mixture wrong |
| F. | Reed valve |
| G. | Replace |
| H. | Worn rings |
| I. | Idle jet |
| J. | Wrist pin |
| K. | Weak valve spring |

